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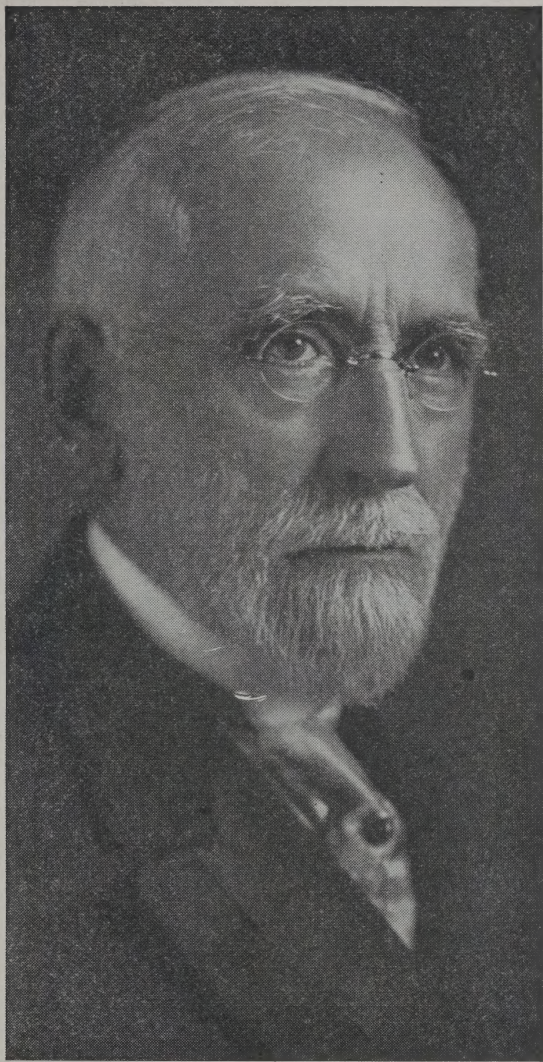
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LYMAN STEWART

1840-1923

Pioneer of the California oil industry; born near Titusville, Pa., July 22, 1840; died September 28, 1923. He preceded Mr. Rockefeller two years in entering oildom, and at the time of his death was chairman of the board of directors of the Union Oil Co., of California, which he founded and with which the author was once connected. Among his more notable beneficiaries is the extensive Bible Institute of Los Angeles.

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OILDOM

ITS TREASURES AND TRAGEDIES

A PROFUSELY ILLUSTRATED BOOK OF LATE
AND BASIC FACTS ABOUT PETROLEUM AND THE
DEPENDENT OIL AND AUTOMOTIVE INDUSTRIES

POPULARLY PRESENTED FOR THE BENEFIT OF INVESTORS, MOTORISTS
AND OPERATORS

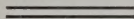
BY OSCAR H. REINHOLT, B. S.

Engineer and Geologist; Specialist in Mineral Resources; Fuel Explorer in the
Philippines for the War Dept., 1903-4; Co-Editor, Revised "Manual for the
Oil and Gas Industry," U. S. Treasury Department, 1921; Chief, Depart-
ment of Mines and Metallurgy, Sesquicentennial Exposition, 1926;
Professor of Chemistry and Geology, Hartwick College, 1929-30

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PART ONE

Covering International Phases, Natural History, Commercial Geology,
Mechanism, and Economic Relations of Crude Oil, Gasoline
and the Automotive Industry



David McKay Co., Publishers
South Washington Square, Philadelphia

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Part One, 1924

Part Two, 1927

Part Three, 1930

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OUTLINE OF CONTENTS—PART ONE *p. 1*

I. THE PETROLEUM PANORAMA—International Treasures and Tragedies, Turkish Petroleum and the Open Door, Averting Another Tragedy, Advantage of Latin America, Engineers as Diplomats, Restrictions on American Enterprise Abroad, World Reserves and Present Sources, American Dominance, Why Other Nations Seek Own Supplies, Domestic Position of Mineral Oil.

II. The NATURAL RESOURCE—Nature, Origin of Oil, Surface Signs of Deposits, Geologic Occurrence and Distribution, Geologic Treasures and Tragedies.

III. COMMERCIAL GEOLOGY—Description of the Major American Fields: Mid-Continent, California, Gulf Coast, Appalachian, Rocky Mountains, Illinois and Lima-Indiana, Canadian Occurrence and Development, Summary of Salient Facts.

IV. MECHANISM OF THE INDUSTRY—Technologic Foundations and Dearth of Petroleum Engineers, Conservation of Underground Reserves, Three Great Problems, The Tragedy of Poor Recovery, Conservation of Capital Through Core Drilling, Developing, Producing, Transporting and Refining; Technologic Treasures.

V. ECONOMIC ASPECTS—Importance and History, Problems and Preliminaries, Production of Crude Oil, Peak and Economic Limit, Yield Per Acre and Per Well, Overproduction from Deep Wells, Tragic Consequences.

VI. ECONOMIC ASPECTS (continued)—Price Changes and Market Panics, Premiums, Causes and Cures for Overproduction, Storage and Stabilization, Manufacturing and the Refined Products, Costs and the "Soup-bone" Tragedy, Rate of Refining, Transportation by Tank Cars, Pipe Lines and Tankers, Distribution and Utilization, Tragic Loss of Lubricants, Coal versus Fuel Oil, Conservation.

VII. GASOLINE AND THE AUTOMOTIVE INDUSTRY—Three Sources, Growth in Yield, Use and Stocks; Alcohol, Benzol and Other Substitutes; Conservation of Motor Fuel; Practical Economics for Auto Owners; Treasures and Tragedies.

PUBLISHER'S STATEMENT—PART TWO *p. 130*

Lovers of truth like a book of this type which is both entertaining and instructive. Part One is aimed at the man with the car; Part Two, at the man with the money; both parts, at the man within the oil industry who wants to advance in the field, in the refinery or from the filling station. How well and widely Part One was received is clearly indicated by the comments abstracted at the end of the 12-page index. Not only is the complete book readable and serviceable as a text but it is particularly useful for reference because of its wide range of subjects and the minute division of its content. It is easier to list its omissions—largely legal and technical—than its inclusions since it is so encyclopedic and takes the place of half-a-dozen separate volumes on petroleum. This annual should have a place on the shelf of every banker, bond dealer and other investment adviser. It should interest all intelligent Americans wanting important facts about one of the world's international problems. It is also commended to all law-makers who may have to consider petroleum legislation.

Philadelphia, Sept. 1, 1927.

PROVISIONAL SUPPLEMENT TO PARTS ONE AND TWO *

A truce has been declared in the world struggle for oil. But the third oil producer, Russia, is still reluctant as to indemnifying British investors; and Venezuela, now the second nation since Mexico's decline, has discouraged new development to the point that one American operator (Gulf Oil) has withdrawn therefrom. Persia is now pressing Mexico for fourth place and Colombia is coming up, having now about twice the output of Peru, or about the same as the

* PART TWO, of 270 pages and 150 illustrations, covered Finance, Geography, Governmental Relations, the Human Element, Latin America and the Prevention of Frauds and Failures. Crowded out of it was the humorous chapter entitled "Laughing Gas and Lubrications" which will appear in the forthcoming PART THREE. That supplement will more completely present the important facts about mineral oil and the petroleum industry as they pertain to the years 1927, 1928 and 1929.

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Dutch East Indies, or almost as much as Rumania. The billion-barrel yield in the United States boosted world production to 1,450 million barrels in 1929.

RECENT GROWTH IN THE PRODUCTION OF PETROLEUM IN THE UNITED STATES

Year	Million Bbls.	Mil. Dols.	1st State	Year	Million Bbls.	Mil. Dols.	1st State
1924	714	1,023	Calif.	1927	901	1,172	Okla.
1925	764	1,285	Calif.	1928	902	1,100	Texas
1926	771	1,448	Calif.	1929	1,000	1,250	Texas

Stocks of all kinds reached a new record of about 680 million barrels at the end of the year. Gasoline production approximated 440 million barrels, of which 56 per cent was from straight run or ordinary refining, 33 per cent from cracking, and 11 per cent from vapors of oil wells and natural gas. If the 52 million barrels of such natural gasoline be added to the quantity of crude oil, the total liquid mineral fuel produced in 1929 makes 1,058 mil. bbls., 70 per cent of the world's.

RANK OF 18 STATES IN OUTPUT OF CRUDE OIL IN 1929 AND TO DATE

(Millions of barrels of 42 gallons)

State	1929	Total	State	1929	Total	State	1929	Total
Texas	299	2,075	Wyoming	19.2	315	Michigan	4.4	5.0
California	293	3,275	Pennsylvania	11.8	825	New York	3.3	75.
Oklahoma	254	2,770	Kentucky	7.8	105	Montana	3.2	35.
Kansas	43	510	Ohio	6.7	555	Colorado	2.3	23.
Arkansas	25	340	Illinois	6.3	385	New Mexico	1.7	8.
Louisiana	20	425	W. Virginia	5.5	370	Indiana	1.0	117.

Early in 1930, the three leading oil areas were the Los Angeles basin, the West Texas (Permian) basin and the Seminole (Okla) district. The daily rates of these ranged from 300,000 to over 400,000 barrels. Curtailments, notably in the first of these, have reduced the daily yield in the United States from nearly 3,000,000 barrels about Sept. 1, 1929, to less than 2,650,000 barrels on Jan. 1, 1930, or an average rate of almost 8 barrels per well per day.

Remarkable are the new records established in deep drilling and in production. Wells are now being bored in the Los Angeles basin to depths beyond 9,500 feet, using electric power and rotary tools. The deepest producer in the Mid-Continent field was drilled with cable tools to 8,532 feet in Reagan County, West Texas. It came in at Thanksgiving, 1928, flowing 80 bbls. daily. In two months it paid for itself and increased to 2,000 bbls. and to 55 per cent gasoline. California's 7,000-foot wells at Santa Fe Springs, Long Beach, Ventura (page 151), and especially in the Kettleman Hills (San Joaquin Valley), are likewise yielding light oil. The last named field promises to produce more oil than any other field in the world.

As a result of all this deep development, the weighted average depth (page 105) of production has "risen" to about $\frac{3}{4}$ of a mile. The aggregate depth of our 1-3 million wells approximates the distance to the Moon. The cost of drilling and lifting has increased enormously and now exceeds \$1,200,000,000 per annum. Relatively shallow wells in West Texas, some with over 130,000 bbls. initial per day, have proven bonanzas to their owners and have broken the records of the Lucas (page 41) and the Lakeview (151) gushers. If allowed to flow to capacity, they could have boosted the daily average in 1928 to more than 20 bbls. per well.

Exports of refined products, notably gasoline, are advancing in volume and value. But because of the enormous expansion in world demand for American automobiles, mineral oils no longer rank next to cotton among our exports, measured in money. They average about \$500,000,000 worth per annum and make about 10 per cent of total exports. Los Angeles and New York are the two leading oil ports, considering both coastwise and foreign trade. At all the other six or seven leading sea-ports, petroleum remains preeminent as to tonnage in all trade.

Despite continued domestic competition, evidenced by the overbuilding of filling stations and the extension of household heating with oil, the operators are prosperous and are gradually agreeing on unit development of new pools in line with what Henry L. Doherty has advocated for years. The U. S. Oil Conservation Board, appointed by President Coolidge on Dec. 19, 1924, is harmonizing Federal activities in cooperation with state authorities and the leaders in the industry itself. Water-drive in New York and Pennsylvania and air-lift elsewhere are increasing the recovery of oil per acre and per well.

PREFACE

"Conservation of Capital" is the key-note of this little contribution to petroleum literature. The conservation of the natural resources in oil and gas has already received proper consideration in various publications. As a result of the co-operation of the United States Geological Survey and the Bureau of Mines with wide-awake operators the former woeful waste of these natural treasures has been remarkably reduced. With the rapid growth of the oil industry during the last decade redoubled efforts have been exerted by other Government agencies to discourage the evil practices of oil promoters and pseudo-geologists. Uncle Sam, however, neither can nor will take away the personal liberty of being humbugged.

During the past five years an average of almost 150 million dollars has been annually lost more or less honestly, but not always unavoidably, in unsuccessful drilling for petroleum. No one presumes to know exactly how much additional good money has gone overboard in the storms of stock and lease speculations; but very likely at least twice that sum was thus lost during the boom year of 1919. Three dollars for each man, woman and child in the United States does not seem so appalling as it would be if the loss were distributed at the rate of \$300 each among one million "investors." This estimate in the aggregate was actually under 10 per cent of the 3 3-4 billion dollars total authorized capital of the 1629 oil companies organized throughout our country in 1919; but it actually approximated the entire output of all the world's gold mines in any recent year.

The Treasures and Tragedies of Petroleum are numerous, notable, and varied. The famous asphalt deposits of Rancho La Brea near Los Angeles have proven a veritable treasure vault to science. The embalmed bones of camels, elephants, lions, and saber-tooth tigers found there represent a geologically recent tragedy of rare occurrence in nature. As a treasured commodity of international trade, petroleum would not yet have yielded its comforts and conveniences to man were it not for the treasure seekers, intrepid geologists, and patient technologists, who, in their various ways have pioneered and improved the greatest branch of the American mining industry. Treasures in the form of income to royalty owners, stockholders, and employees are all self-evident. Not to be overlooked, however, are the many public improvements and benefactions that have helped to advance civilization and have derived their funds from the oil industry. Suffice it here to mention one—the Rockefeller Institute for Medical Research which has reached even to China with its helping hand. Two great tragedies are "portrayed in oil," respectively in the picture of a motorless America a hundred years hence and in the realization that human parasites steal millions each year and drive many investors to suicide.

How to avert the one of these tragedies by providing intelligent investors with means for their own protection against misadventure in oil,

has been the main motive in preparing this book. The latest and most reliable information on mineral oil and the dependent industries has been collected, classified, and condensed for the benefit of both the investor and the general reader. Some money-saving advice is given to the many investors and other readers who are also motorists. This, together with late statistics of the automotive industry supplement the chapters on Economics. The economic and other treasures of the motor car are quite obvious but facts about avertible tragedies must needs be told effectively. The attempt has been made to present the serious facts in a brief and popular form; just a little has been added in a lighter vein for entertainment and good measure. Practically all the topics taken up have been treated more deeply in publications to which references have been made. Interested readers are invited to suggest improvements for future editions. They may be mailed to the author, in care of the Chamber of Mines and Oil, Los Angeles, California, or the Technical Research Institute, 601-5 Star Building, Washington.

OSCAR HALVORSEN REINHOLT.

Washington, D. C., Jan. 16, 1924.

ACKNOWLEDGMENTS

The principal inspiration truthfully to portray the oil business as it is today has come from contact with scientific workers in Washington and with Natural Resources cases of the Income Tax Unit that imply a ridiculously low percentage of success among the many American oil companies that have been organized. The surcharging of the atmosphere at the Capital, not with factory fumes, but with unburned carbon, carbon-monoxide and gasoline vapor from the exhaust of automobiles in the downtown district, has led the author to devote special space to the subject of gasoline and its waste in an effort to help save hundreds of millions yearly misspent.

Individual thanks are herewith extended to those men who have contributed material or otherwise encouraged the writer: Mr. P. E. Barbour, Assistant Secretary, American Institute of Mining Engineers; Commissioner Burke and Mr. T. B. Boone, an attorney, of the Indian Bureau; Major W. DuB. Brookings, of the U. S. Chamber of Commerce; Secretary J. F. Callbreath, of the American Mining Congress; Mr. A. H. Fay, former associate of the author in the Oil and Gas Section and for two years head of the Natural Resources division in the Bureau of Internal Revenue; Mr. J. C. Fitzsimmons, sales manager of the leading producer on the Pacific coast; Mr. J. O. Jenson, banker and former oil operator, of Clifton, Texas; Mr. G. E. Mitchell, member of the U. S. Geological Survey and writer for the *Scientific American*; Messrs. H. C. Morris, chief, and A. T. Coumbe, Jr., assistant chief, Petroleum division of the Department of Commerce; Dr. W. H. Raymenton, naturalist, of Worcester, Mass., and San Diego, Calif.; Mr. W. A. Reid, foreign trade adviser, Pan American Union; Mr. A. H. Redfield, of the Foreign division of the Survey; Mr. G. B. Richardson, chief of the Petroleum division of the survey; Mr. W. W. Orcutt, vice-president of the Union Oil Company, of California; Secretary G. M. Swindell, of the California Chamber of Mines and Oil, Mr. H. T. Walsh, vice-president of the Sullivan Machinery Co., Chicago; Mr. David White of the Survey; and also the publishers of the various books and periodicals who have been specially credited for illustrations or quotations reproduced.

OILDOM:

ITS TREASURES AND TRAGEDIES

By OSCAR H. REINHOLT

PART ONE

CHAPTER I. THE PETROLEUM PANORAMA

"While our Government has been trying to organize a model state of society, other great states have been looking about for the means to dominate the petroleum production of the world, because of their conviction that in the control of petroleum they might find the power to control the commerce, the trade, and the industry of the twentieth century world."—Warren G. Harding, 1920.

International Treasures and Tragedies. The very great and growing importance of petroleum throughout the world is being emphasized by current events. The year 1923 has been full of happenings that prove how essential mineral oil has become to our industrial life and how involved it is with international commerce and politics. Not only have the daily



REAR ADM. COLBY M. CHESTER,
U. S. N.

To whom the Turkish Government has granted great concessions in Asia Minor. (See map, page 9.)

newspapers been deluged with long news items, but certain popular magazines have devoted page upon page to reviews of various oil situations.* Pessimistic writers have even prophesied that the next world war will be fought for the possession of oil deposits as the last one was instigated by Germany's greed for greater resources in coal and iron ore.

The Chester concession,** relating in part to the Mosul region of Kurdistan, is a late affair to receive public attention. Interest therein has been aroused because of the spreading realization that from foreign sources must be taken more and more of the future supply of petroleum to meet the varied and voracious demands of America for lubricants and liquid fuels.

Other International Petroleum Problems. Among other affairs with an oily flavor may be mentioned the recognition of Russia's misgovernment

* See especially, "World Race for Oil," *The Literary Digest*, January, 1923, and "Civilization and Oil," by Leo Pasvolksy, *Atlantic Monthly*, February, 1923.

**Seventeen years after meeting the Admiral at the 8th International Geographic Congress, the author heard him describe the Kurdistanian fields. In the course of his lecture he credited David White of the Geological Survey with broadcasting the facts which explain why our country must seek foreign supplies. See "The Importance of Mosul in the Oil World," *Current Opinion*, June, 1923; and "Berlin to Bagdad and the Chester Plan," *The Nation's Business*, July, 1923.

which depends so much upon the restoration of petroleum rights to foreign interests that have developed Baku and lesser fields. The recent recognition of the Obregon government was deferred by the United States until the dark clouds of confiscation had been dissipated to the satisfaction of American owners of Mexican oil lands.

Perhaps it is providential, for the good of civilization, that two fair-minded nations together so largely monopolize the earth's resources, production and commerce not only in petroleum but also in gold, iron, coal, copper, cotton, wheat and wool. According to Barron's* "England has the lines of world communication and dominion in colonial administration and upbuilding. English capital and credit is being allied with American capital and management in a world's steel development. Foundations are being put under the peace of the world that mean much for world development. Whatever may be the appearance of local friction, Great Britain, the United States, France and Italy are moving forward in closer co-operation than is locally realized. The Mediterranean is a pivotal point in that co-operation and that future development."

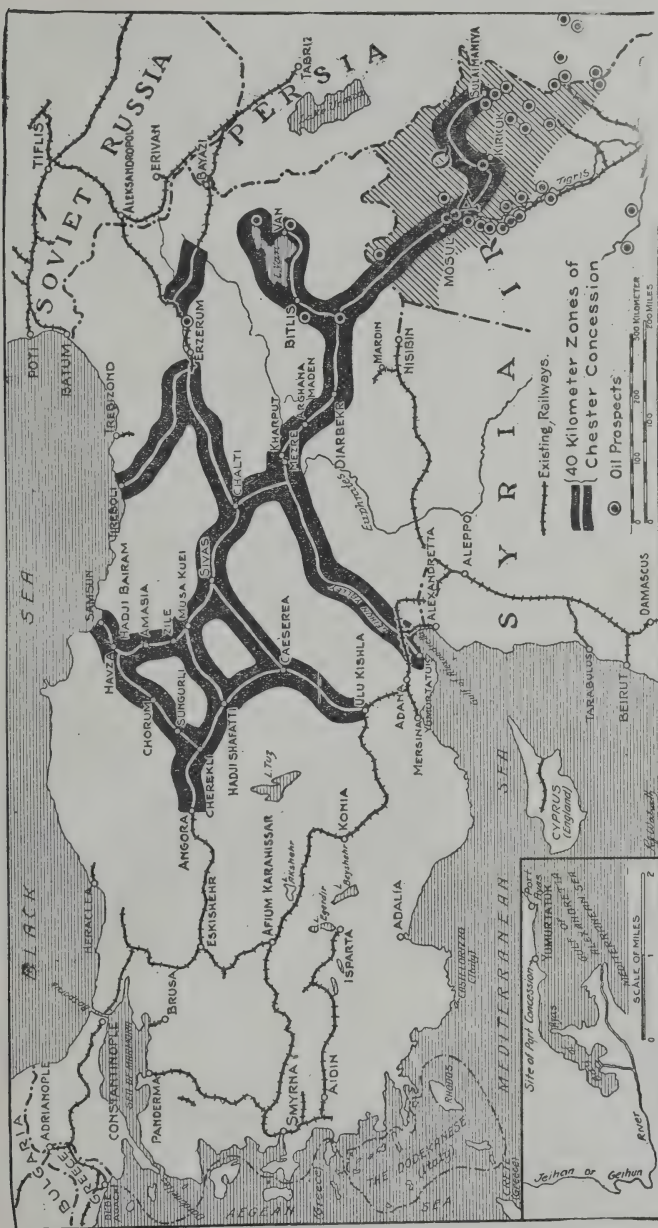
Americans and Turkish Petroleum. The long diplomatic contest between France and England for the petroleum of the Mosul area in the upper Tigris region, which has been one of the dominating though underlying factors in various conferences, from Rapallo to Lausanne, became further complicated when Turkey by force of arms established her right to be recognized and dealt with politely. Upon this happening, Turkey herself protested against the tapping from her ancient territories of the Mosul petroleum, and this obstinate wish was one of the reasons why the Lausanne conference broke up, although even the American representative advised her to yield. Now Turkey has cleverly drawn a new element into the situation by ratifying the Chester concession, which gives an American syndicate the right to develop petroleum in this region and cancels an earlier permission secured by France. The move was clearly political on Turkey's part, for the Chester concession is an ancient one, dating back to Abdul Hamid.†

It is interesting to note that no foreign oil interest has been positively mentioned as being behind the French and British protests. Nevertheless, it may well be that it is but another phase of the old struggle between the Dutch-Shell and the Standard interests. In this respect it is interesting also to note, in so far as the British protest is concerned, a statement by Admiral Chester: "Counting the world war, Great Britain has sacrificed 100,000 men in her determination to monopolize Turkish oil. We are in Turkey to stay. Great Britain and France would not let us thru the front door so we have effected a rear entrance. The door will stay open for all time. The world may as well become reconciled to giving up part of its oil. In our country we have not enough, yet our automobiles and machines are multiplying so fast that we are facing a fatal shortage. Our commercial life depends upon an adequate supply of oil.

"Geography and history will help our people to understand why this fight has been made in such intensity. It must be remembered that the

* Issue of April 16, 1923, in article on "Mediterranean Issues—Airplanes and Mesopotamian Oil" by C. W. Barron, President of Dow, Jones & Co., publishers of *The Wall Street Journal*.

† Editorial in *Engineering and Mining Journal*, April 28, 1923, J. E. Spurr, Ed.



MAP SHOWING THE EXTENT OF THE CHESTER CONCESSION IN ASIA MINOR AND THE PROPOSED STATE OF IRAQ, WHICH ONE POWER IS TRYING TO SET UP IN PART OUT OF KURDISTAN TERRITORY INCLUSIVE OF THE CHOICE OIL REGION AROUND MOSUL. —Courtesy of the Oil Trade Journal.

Officials of the Ottoman-American Development Co. denied the report from Constantinople that the Chester concession for the development of mineral and oil lands in Anatolia had been annulled. They claim the right to abandon any of the 15 projects if found, after study and engineering survey, to be worthless for purposes of development. Only one of these has been abandoned, and a London syndicate, it seems, has been formed primarily to develop this small part of the original Chester concession. (Abstract from the N. Y. Times, Dec. 20, 1923.)

world war was fought over oil. Britain invaded Turkish territory, in the oil region (according to official reports) two weeks before war was declared between those countries.

Averting Another International Tragedy. In recommending the creation of a council of 25 experts, elected at large and independent of Congress, to handle our foreign affairs, Mr. Frank A. Vanderlip said, at Washington, May 12, 1923:

"We are admonished not to covet our neighbor's house. But what about his territory, his **oil fields**, his ports? There was a coveting of territory in Europe which resulted in 25 million refugees driven from their homes. * * * There was in Europe a coveting of oil wells which has set the whole Mohammedan world afire and brought a fresh threat to civilization."

Passing the question of political dominion over the Mosul region, France and Great Britain must admit that, if either of them should undertake through her nationals to develop that petroleum territory, she would eventually call upon the United States to supply some, if not all, of the capital, equipment and skilled labor essential to economic success. Knowing that astute Turkey realizes their semi-dependence upon the United States in this respect, France and Great Britain may become content to leave the responsibility of the petroleum development to Americans and amicably to arrange, on equitable basis for the procural of the crude oil which they may require. While more embittered politically against Great Britain, Turkey, at the same time, has not forgotten the French fiasco of the Panama Canal; she must have greeted with glee the announcement that General Goethals, the canal builder, would direct the half-billion dollar enterprise if the Chester concession be brought to fruition.*

On the subject of international cooperation as opposed to tragic competition, A. C. Bedford** has recently expressed himself as follows: "No one can regard the petroleum situation in the world today in a comprehensive manner without being convinced that a clear vision of all the elements in that problem leads to but one conclusion, and that is the supreme importance of co-operation on the part of the peoples of the world both in exploiting and utilizing the oil resources which nature so sumptuously provided."

Convenient Location of Latin-American Oil Fields. None of the Asiatic fields awaiting development are near enough to the United States to prove very attractive to either the American investor or the American consumer. Beyond any doubt it will cost us much less to bring our future supplies from South America than, for instance, from Mesopotamia, the main difficulty being the dubious attitude of the various Latin-American states toward foreign enterprises essential in the development of their petroleum deposits. As a matter of fact, Columbia, Venezuela, and Trinidad are all about as close to the Atlantic ports of the United States as are the Tampico oil fields of Mexico. American interests, present or prospective, in Armenia, Mesopotamia and Asia Minor, should therefore not be opposed to a mutually profitable apportionment of foreign mineral oil that

* Early in September, 1923, it was reported that Admiral Chester and his associates had sold out to the Kennedy interests for \$300,000 all but 10% of their share of the profits of the Ottoman Development Co. But this report has been proven erroneous.

** Chairman, Board of Directors, Standard Oil Co., of N. J., writing in *Foreign Affairs*, March, 1923.

might some day be produced in Asiatic territory now claimed by Turkey*; nor should American investors at large become disappointed if they be not permitted to share in the Asiatic developments except so far as they are, or may become, stockholders in the American companies mentioned below.



A VENEZUELAN GUSHER

Sensational developments in petroleum production in Venezuela within the next year are expected by experienced oil men. Above view is from E. S. Durward, of the Caribbean Petroleum Co., Maracaibo, and shows a well they recently got in the La Rosa district, flowing 12,000 barrels a day.—Mining and Oil Bulletin, Aug., 1923.

Late in 1922, the Standard Oil Co., of N. J., acquired a 25 per cent equity in the Mesopotamian properties of the old Turkish Petroleum Co., by agreement with the Shell-Anglo-Persian companies and the French interests, of which the latter represent the German pre-war share.** It is questioned if the Barnsdall concessions in the Caucasus or the Sinclair concessions in Sakhalin will ever prove profitable in view of the various restrictions imposed by the Soviet Government.

Engineers Become Diplomats in International Disputes. Sir John Cadman, a leading engineer in British oildom, lately outlined the empire's policy in these words‡: "A weird picture has been drawn about Mesopotamia. The fact is, that the ownership of oil deposits therein will be secured to the Arab state as a part of the administrative arrangements under the treaty mandate. Great Britain is denying the chance to all nationals, her own included, to examine these areas for commercial purposes until she has been charged as a mandate.

"One is led to believe that the British Government is a great oil company, and that it

* In March, 1923, the *New York Times* declared, "The time may yet come when oil will have to be distributed according to the need of each country by international agreement."

** London dispatch to the *New York World*, dated Oct. 26, 1922. American participation was said to be due to the demand of the State Department for equal rights in Palestine and Mesopotamian oil lands.

‡In the February (1922) issue of *Mining and Metallurgy*, quoted by the *Mining Congress Journal* of April, 1922.

has subsidiaries such as the Royal Dutch Shell† and the Anglo-Persian companies. Rumor asks you whether you can afford to become dependent for even a part of your crude petroleum upon such a British combination. You are asked to believe that soon your own internal source of supply will be exhausted. Emphatically, the British Government is not in the oil business. She does not control the Royal Dutch shell—she does not have a single share in that corporation‡—and with the exception of sharing in the Anglo-Persian Oil Company, over which it has no control, the British Government is not interested in oil companies.”

In framing a foreign petroleum policy for our own Government American engineers and engineer-geologists have been called upon by Congress and the State Department to gather fundamental data. Prominent have been Secretary Hoover of the Department of Commerce; his petroleum aid, Mr. H. C. Morris, Dr. David White of the Geological Survey, and Dr. C. K. Leith* as chairman of a committee of the Mining and Metallurgical Society.

The question is held to involve more than petroleum. While nature distributed petroleum unequally throughout the world§ it pursued the same course with other minerals. In some of these, such as copper and iron, the world must depend heavily upon the United States. All agree that restrictions on the international movement of essential minerals should be subject to the minimum amount of control. Nevertheless, there is certain to be more or less trading on the strength of mineral advantages as a result of the acuteness of the oil situation. It is the hope of the Leith committee to be able to furnish information which will make possible a more intelligent consideration of this general subject, when placed at the disposal of the Government.||

The United States should distinguish between immediate economic needs and remote and perhaps unnecessary diplomatic ambitions. It is most legitimate and desirable that for a time we should supplement our American oil with whatever we can get from abroad at a cost which will represent a national saving. Our ultimate native fuel resources are so vast and their extent so continuously enlarged by scientific research that there would seem little reason why we should ever feel obliged to incur any risks of war in distant parts of the earth on behalf of an imported supply of liquid fuel for our country.**

Restrictions on American Development of Foreign Fields. Secretary Hoover of the Department of Commerce said in his annual report, 1922: Early in the administration consideration was given by this Department jointly with the Department of Interior to the serious situation confronting our country in its supply of oil. As a result of a survey of our own

†This foreign concern, largely through the Long Beach discovery made by its California subsidiary, controlled over 4% of the oil output of the United States in 1922.

‡Sixty % Royal Dutch or foreign controlled; only 40% Shell or British. See Federal Trade Commission's report on Foreign ownership in the (United States) Petroleum Industry, made to the Senate, February 12, 1923.

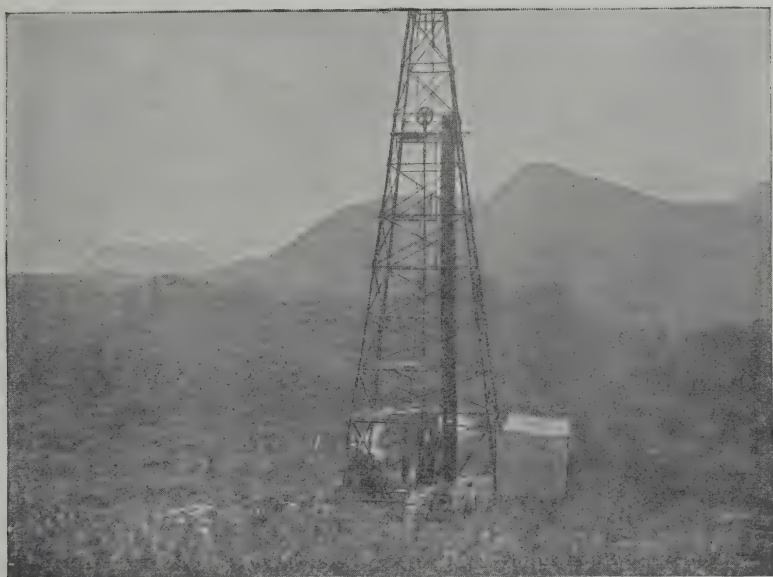
*Adviser to the United States Shipping Board, 1917-18; author of "The Strategy of Minerals".

§See table and map of petroleum reserves.

||Paul Wooton, correspondent of *Engineering and Mining Journal Press*.

**Joseph E. Pogue, quoted in *The Oil and Gas Journal*, May 3, 1923.

and the world situation, it was concluded that our domestic sources of oil would at the present rate of exhaustion last only a generation, and that foreign nations were rapidly pre-empting the available foreign oil-bearing territory. Therefore, unless our nationals could reinforce our holdings abroad, we should be dependent upon other nationals for the supply of this vital commodity in a measurable number of years. As a result of these conclusions, conferences were called with the representatives of the oil industry, and voluntary steps were taken by them to extend their holdings



AMERICAN ENTERPRISE ABROAD

Despite the notorious neglect of our nationals in foreign fields, at least one country—Mexico—owes its modern development of mineral resources to men, money and material from the United States. Here is shown a steel derrick and a diamond core drill made by an American company and used in extending the producing area of an oil field near Tampico.

—Courtesy of Sullivan Mch. Co.

abroad. Departmental reports show a rapid expansion of the foreign interests of our different companies, and they have now reached an extent which should measurably assure to us future supplies under American control. It has developed from these investigations that while our oil-bearing lands are free to the exploitation by foreign corporations, some of the principal countries whose nationals are thus engaged here at the same time prohibit our nationals from similar free access to their territories.

Retaliatory action was taken by Secretary Fall just before vacating his office as Secretary of the Interior early in 1923. In the opinion of the *New York World*:* Nobody is going to solve the international oil problem by making reprisals in Oklahoma against the British and Dutch companies. To shut out capital from the small fraction of the American sup-

*Quoted by *The Literary Digest* of March 31, 1923, page 13.

ply that remains untaken will not open the door in the Near East or in the East Indies. The American interest in the oil policy of Europe and Asia is twofold, first to see available at home a cheap and abundant oil supply and next to insure the sharing of American oil companies in the development of the Eurasian fields. In these oil-fields we have no strategic interest. The oil problem (with us) is a peace problem. It is a question of feeding autos, tractors, gas-engines, locomotives and merchant ships in time of peace rather than of warships in time of war.†

TABLE OF THE WORLD'S PETROLEUM PRODUCTION
in 1912 and in 1922

Showing the Quantity and Percentage Contributed by Countries and Grand Divisions.

Countries	Thousands of Barrels		World's Per cent	
	1912	1922	1912	1922
United States-----	223,000	551,200	63.4	64.8
Mexico -----	16,600	185,050	4.7	21.7
Canada -----	240	180	---	---
Peru -----	1,750	5,330	0.5	0.6
Argentina -----	50	2,670	.0	0.3
Trinidad -----	440	2,450	.1	0.3
Venezuela -----	0	2,340	.0	0.3
Colombia -----	0	320	.0	---
Egypt -----	200	1,190	.0	0.1
Algeria -----	0	10	---	---
Rumania -----	13,000	9,820	3.7	1.2
Poland -----	8,500	5,100	2.4	0.6
France -----	0	500	0.0	0.0
Germany -----	200	1,030	.0	.1
Russia -----	68,000	35,100	19.3	4.1
Persia -----	600*	21,200	.1	2.5
Dutch East Indies-----	10,850	16,000	3.1	1.9
India -----	7,120	7,980	2.0	0.9
British Borneo-----	6‡	2,920	---	.3
Japan and Formosa-----	1,670	2,000	.5	.3

Summary by Grand Divisions.

North America-----	239,840	736,430	68.2	86.5
South America -----	2,240	13,110	.6	1.5
Total America-----	242,080	749,540	68.8	88.0
Asia -----	20,246	50,100	5.7	5.9
Africa -----	200	1,200	0.0	.1
Europe -----	89,700	51,550	25.5	6.0
Australia -----	0§	0§	0.0	0.0
	352,226	852,390	100.0	100.0

10 year gain-----500,164 = 142 per cent. Revised statistics of the U. S. Geol. Survey gives the yield of the United States in 1922 as 557,531,000 bbls.; but the share in the world's yield remains practically 65 per cent.

†In reversing his predecessor's decision, Secretary Work announced May 16, 1923, that corporations controlled by foreign interests are again permitted to obtain oil and gas leases on restricted Indian lands.

*Campbell M. Hunter, of London, quoted in (United States) *Mining and Metallurgy* of February, 1920.

‡Sarawak, from the An. Rep. of the Royal Dutch-Shell Co., quoted by A. H. Redfield in *Economic Geology*, August, 1922.

§As in Scotland the only mineral oil obtained in Australia is shale oil.

Present Dominance of the United States in the Oil Industry. Allowing for 4% foreign ownership at home, and for 80% control of Mexico's oil industry, the United States, through its nationals, last year controlled about 78% of the world's output of petroleum. Including the 23 million barrels produced by foreign corporations, the 551.2 million barrels of domestic oil obtained in our country in 1922 constituted a direct contribution of 65% to the world's output. Our gain of 79 million barrels, or 16.7 per cent over 1921 made up more than nine-tenths of the 86.5 million barrels increase for the whole world. Not in copper, cotton, or corn is our present world supremacy so marked as in petroleum although we export relatively much more of our domestic production of the first two.

Our per capita yield of petroleum has been steadily increasing. It rose from 4 1/3 barrels in 1921 to 5.0 in 1922, promising to become nearly 7 barrels in 1923. No nation except Mexico surpasses us in this respect. Mexico's maximum per capita yield of 13 barrels was attained in 1921, but dropped to 12 barrels in 1922. However, along this line of comparison Mexico, in turn, is excelled by six of our individual states, namely Oklahoma, California, Wyoming, Texas, Kansas and Arkansas.

In consumption, our leadership is more pronounced and is not, on a per capita basis, approached even by Mexico which usually retains and uses less than 5% of her production. With only 7.5% of the earth's land area and with only 6% of its population we are consuming 70% of its crude mineral oil, and fully 80% of one refined product, namely gasoline.

The Bureau of Mines* has published statistics of the quantity of petroleum used in 1921 by certain countries. The units have been converted from gallons to barrels of 42 gallons each and are given herewith in millions:

United States.....	525.	China	4.8
United Kingdom.....	33.3	Japan and Formosa.....	3.2
Canada	9.5	Chile	3.0
France	8.9	Mexico	1.3 ?
Dutch East Indies.....	5.4	Australia	1.2

These figures for 1921 become significant if expressed in consumption per person, as shown below:

United States.....	4.8	China	0.011
United Kingdom.....	0.7	Japan and Formosa.....	0.053
Canada	1.1	Chile	0.80
France	0.2	Mexico	0.10
Dutch East Indies.....	0.11	Australia	0.22

From the above it appears that we consume 4.4 times as much per capita as Canada. The latter relatively uses 10 times as much as the Dutch East Indies and they in turn, use 10 times as much as China despite its huge consumption of kerosene. Thus our consumption of petroleum per man, woman and child appears to be, roughly, 400 times that of China. It may be truly said that the per capita consumption of mineral oil is fast becoming an index to the progressiveness, if not the extravagance, of civilized nations.

*Estimates by W. C. Hill, published in the *Oil and Gas Journal*, November 4, 1922.

Efforts of Some Countries to Find or Open Domestic Deposits. Four instances are cited of activities in coal producing countries seeking domestic supplies of mineral oil.

England, during the past eight years, has expended over \$2,000,000 in drilling almost 31,000 feet of test wells within her boundaries without discovering oil of any commercial consequence. The value of the petroleum produced has been estimated at less than \$100,000.*

In South Africa the Northwestern Cape Colony Prospecting syndicate has for 20 years been boring for oil near Carnarvon. Efforts in that immediate locality were lately abandoned after an English expert reported adversely.† The Government of Australia has a standing offer of nearly one-quarter million dollars reward for the discovery of mineral oil in paying quantities within that commonwealth. So far only two likely structures have been found and a trial bore is being sunk on one of them.‡ After spending about \$150,000 the Government has given up its own test at Roma, owing to an excessive inflow of water.§

However, British oil companies, operating outside of the Empire, have met with more success, particularly in Mexico, Persia, the United States, and Rumania. The total amount has been estimated at 52.6 million barrels by a London authority but the published list appears to be incomplete. After allowing 40% of the Royal Dutch-Shell Company's output in the United States (23 million barrels in 1922) and say 60% of the entire Persian output (21.2 million barrels in 1922), the British oil companies controlled, in 1922, at least 75 million barrels of petroleum or approximately 9% of the world's production.||

Aeronautical France, which has been getting most of her gasoline, illuminating and lubricating oil from America and paying a seemingly high price for the first named, has bestirred herself since recovering from Germany the Pechelbronn oil "mines" in Alsace. Even with new shafts over 1000 feet deep compared with the earlier diggings of 40 to 300 feet, the **annual** output is not expected to exceed half million barrels, or no more than the **daily** rate of Oklahoma alone at the middle of 1923. To supplement this seemingly small amount of domestic production the French people are now normally importing in a year nearly 9 million barrels of petroleum products. Various steps have therefore been taken to reduce the requirements from foreign sources. These include encouragement to further prospecting in France, Algeria and Madagascar and the legal obligation of importers, beginning August 28, 1923, to buy of the Government 1-10 as much motor alcohol as the volume of gasoline imported. In October, a liquid fuel congress and exposition were held in Paris. Both

*Wall Street Journal, December 4, 1922. According to Trade Information Bulletin No. 80 of the Bur. of For. & Dom. Com. January 29, 1923, the English discovery was made at Hardstoft in Derbyshire. Similar high grade oil was found 300 miles away and 1,800 feet deep near Edinburgh, Scotland, in May, 1921. See also chapter on Commercial Geography.

†United States Commerce Reports February 5, 1923.

‡*The Oil and Gas Journal*, January 25, 1923, Page 136.

§*The Mining Journal*, London, December 30, 1922.

||In September, 1923, the Royal Dutch-Shell Co., was getting ¼-million barrels of oil daily; 80,000 in California, 40,000 in Mid-Continent, 100,000 in Mexico and 30,000 in other fields.—R.Airey of the Asiatic Petroleum Co., quoted in *The Oil and Gas Journal*, September 6, 1923.

proved disappointing as to the expected attendance of foreign producers, refiners and marketers who might have valuable trade or technologic secrets to reveal.

Why Nations Seek Own Sources of Oil Supply. In general, the more civilized foreign nations are ambitious to have their citizens own or control petroleum deposits—colonial, domestic or foreign—sufficient for two purposes: (1) Industrial independence from the United States with special reference to the refining of the crude oil; and (2) military demands which, for countries like Germany with negligible domestic deposits, involve reserve storage of large quantities of lubricants and gasoline. Some authorities say that the Central Powers were defeated as much through their shortage in these supplies as through any privations and propaganda that influenced their folks at home.

Special reasons impel some nations, notably Great Britain, Netherlands and Norway, to encourage their nationals in the quest of petroleum

deposits. The countries mentioned are to a great degree dependent upon shipping as a source of national income, and it is but a question of time before fuel oil will entirely displace coal for marine motive power, particularly if the Diesel engine should be universally adopted. As a matter of fact, the merchant marine of the world consisted of oil-burning vessels to the extent of 26 per cent in 1922 compared with only 3 per cent eight years earlier.

Lord Curzon* has stated that whereas Great Britain imported nearly 3½ million tons, or over 23 million barrels,† of oil in 1920, her domestic production (presumably from Scotch shales) was only 166,000 tons, or a little more than 1 million barrels.

Of the oil imported, 61% then came from the United States, 37% from other countries, and only 2% from the British possessions. Yet 90% of the British navy is now oil-fired, and the use of oil is increasing in the mercantile marine, so that the urgency of a supply of oil is manifest.

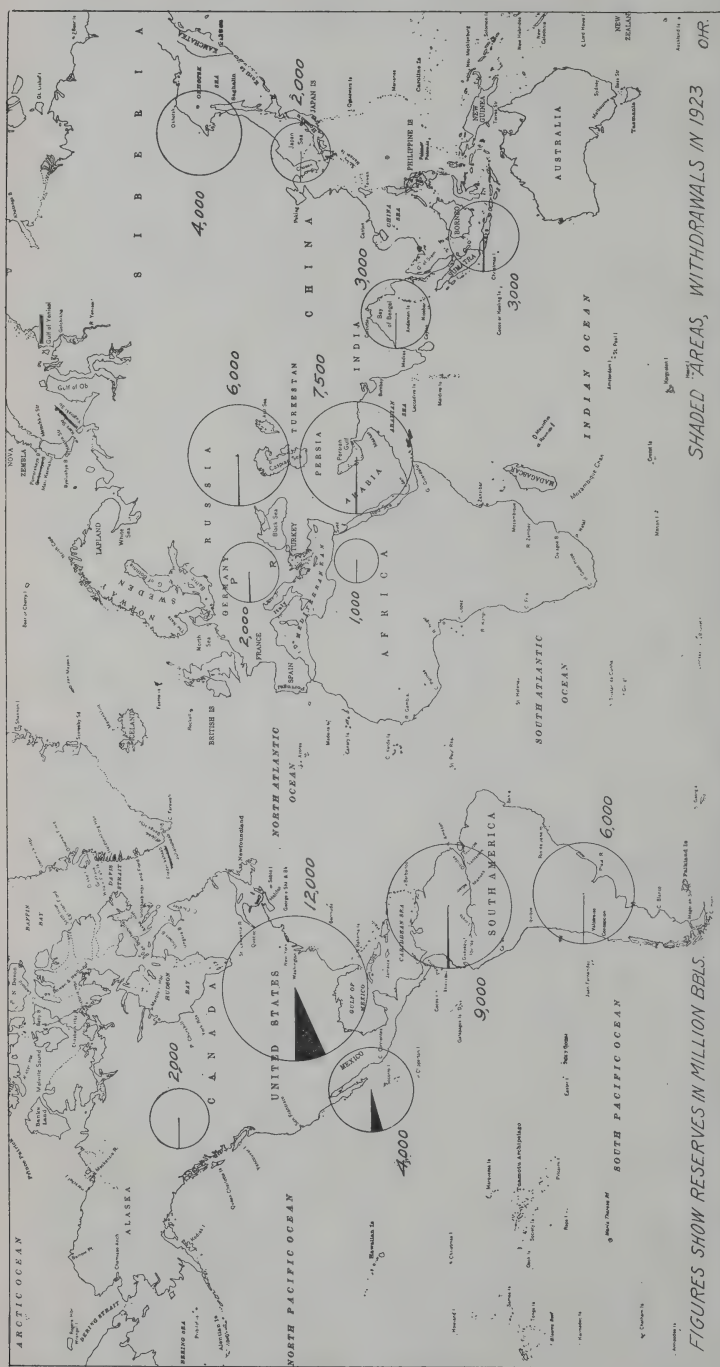


CAPT. ROALD AMUNDSEN'S SCHOONER "MAUD" at Seattle, taking on petroleum supplies for its Arctic cruise, June 4, 1922. Note the Norwegian flag and crowd on dock and roof. Gasoline will again be needed for the next attempt of the South Pole's discoverer to find the North Pole.

—Courtesy Union Oil Co. of Calif.

*Quoted in an editorial of the *Mining and Scientific Press*, July 16, 1922.

†Increased 67% to 34.3 million barrels in 1922.



FIGURES SHOW RESERVES IN MILLION BARRELS.

SHADED AREAS, WITHDRAWALS IN 1923.

OIL.

RESERVES OF THE WORLD'S KNOWN OIL REGIONS IN RELATION TO THEIR PRESENT RATE OF PRODUCTION.

Note the relatively enormous rate of withdrawal of oil from the hitherto vast reserves of the United States and Mexico. At the present rate, their combined supplies underground will last not much longer than 18 or 20 years. (See table, page 19.) America has recklessly and in 60 years run through a legacy, that, properly conserved, should have lasted for at least a century and a half. Just when Americans have become accustomed to use 20 times as much oil per head as the Brits; just when invention has indefinitely expanded the need of oil in industry; just when it has grown to be as common and as true a saying that 'oil is King' as it was twenty years ago that steel was king—the United States finds her chief source of domestic supply beginning to dry up and a time approaching when instead of ruling the oil market of the world she will have to compete with other countries for her share of the crude product. . . . America is running through her stores of domestic oil and is obliged to look abroad for future reserves."

—E. Mackay Edgar in *Spartan's Journal*, England, September, 1919.

WORLD'S KNOWN RESERVES, PRESENT PRODUCTION RATE AND REMAINING YEARS OF LIFE, JAN. 1, 1924.

Country and Grand Division	Remaining* Reserves Millions of Barrels	Yield 1923	Life Left At 1923 Rate
United States -----	12,000	735	16
Republic of Mexico -----	4,000	142	28
Dominion of Canada -----	2,000	1 (?)	--
Northwestern } Peru -----		7	
South } Venezuela -----		6	
America } Trinidad -----	9,000	3	500
		2	
Rest of } Argentina -----	6,000	5	850
South } Bolivia, etc. -----		2	
America }			
Rumania, Poland, etc. -----	2,000	17	120
European Russia -----	7,000	35	200
Siberia and Sakhalin -----	4,000	0	--
Persia and Mesopotamia -----	7,500	25	300
Japan and Formosa -----	2,200	2.2	--
China -----	1,500	.1	--
India -----	2,800	8.2	350
East Indies -----	3,000	20	150
Egypt, Algeria, etc. -----	1,000	1.2	800
SUMMARY			
North America -----	18,000	878	20.5
South America -----	15,000	25	600
Europe -----	9,000	52	160
Asia -----	21,000	55.5	380
Northern Africa -----	1,000	1.2	800
Total quantities, average life -----	64,000	1,011.7	63

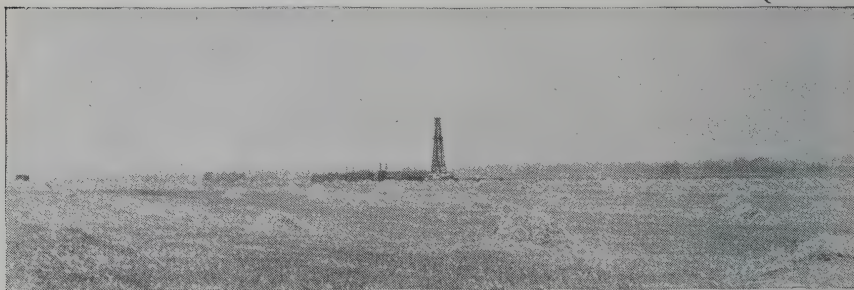
Position and Importance of Petroleum in the United States. Nowhere in the world does petroleum and its dependent industries present so many important phases and effect, as in this country. In only one other nation is it more significant in any respect, namely in Mexico where of late it has, through taxation, furnished nearly all the funds needed to support the Federal government. While making but one per cent of the entire revenue received by Uncle Sam in the form of income tax for 1919, the total of 38.6 million dollars derived from the oil and gas industry proved no mean amount that year. It then made up 51 per cent of the income tax levied on the American mining industry, compared with 23.6 per cent to the credit of coal mining.

The most vital relation of petroleum is not, after all, toward transportation—aerial, terrestrial and submarine—but towards the basic food-producing branch of industry, ancient and honorable agriculture and stock-

*These estimates represent the author's modifications for January 1, 1923, of the White-Stebinger approximations appearing in *Oildom*, October, 1922. David White, in *The Mid-Pacific Magazine*, June, 1923, wrote that wild estimates are better than none and that the obligation of the geologist is to make them as good as possible; but that they will be often revised during the next half-century with advances in geologic explorations, drilling tests, commercial production, and technical discovery. S. K. Hornbeck, of the U. S. Department of State, in addressing the "Raw Material" conference at Williamstown, Mass., August 11, 1923, mentioned 70,000 million barrels as the latest measure of the world's petroleum resources.

raising. "The general employment of the tractor and oil-driven equipment in this field suggests great possibilities to follow in saving labor on the farm and increasing production not only of food but also of fiber. Julius H. Barnes, president of the Chamber of Commerce of the United States and an international authority on grain, recently said that while the agricultural industry was not generally considered to be highly mechanized, the wheat crop of today, if the same crop were produced by the methods in vogue before the invention of the reaper and other mechanical devices, would require 130,000,000 working days' labor. The American worker produces yearly an average of 12 tons of cereal per worker, compared with an average of only $1\frac{1}{2}$ tons per farm worker of the world at large. The tractor and oil-driven equipment will more than make up for the 1,700,000 fewer workers on the farm in 1920, compared with 1910. They will help solve the problem of labor and production costs which now engross the minds of our farmers."*

In some states as in Oklahoma, the economic situation of the oil industry must be considered in weighing the condition of the farmers. Many hundreds are getting an annual revenue from leases of land not yet developed and large numbers are drawing royalties. But oil is not yielding direct revenue for the great majority of farmers.



—*Oil and Gas Journal.*

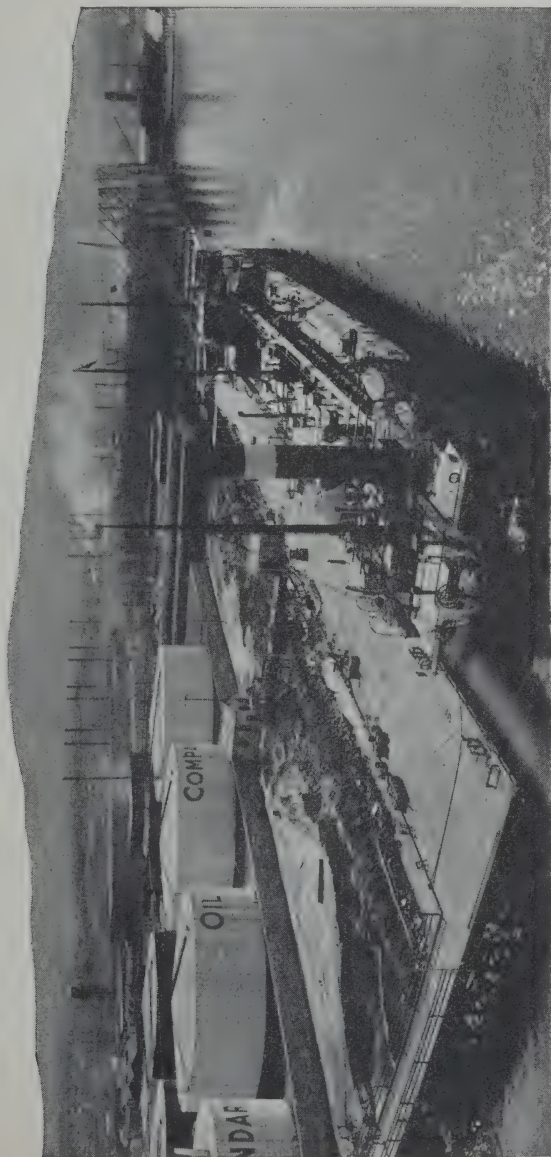
GRAIN FIELDS AND ORANGE GROVES GIVE WAY TO GOLDEN OIL.
Discovery well at Compton, latest new field in Southern California, 1923

One does not think of New York as an oil town, yet nearly a quarter of its total trade as a port is in petroleum and petroleum products. Most astonishing is the fact that in 1922, in point of tonnage, mineral oil made first place in the total traffic of each of the six leading sea-ports of the United States, namely New York (19,000,000 tons total traffic), New Orleans (6,700,000), Baltimore (5,200,000), Philadelphia (5,150,000), Port Arthur, Texas (4,800,000), and Galveston.† During the fiscal year of 1921, petroleum and its products were exported to a value exceeding 500 million dollars. In 1922, with a value of almost 350 million dollars and a rank next to cotton and wheat including their manufactures, mineral oil made up nearly 10 per cent of the total value of all domestic merchandise exported. Oil traffic through the Panama canal was paying 50 per cent of the Government tolls during 1923, and at one time during the latter part of this year it was moving east at a rate of almost 150 million

*Editorial from *The Oil and Gas Journal*, May 17, 1923.

†*The Literary Digest*, June 17, 1923, page 70.

barrels or more than 20 million tons per annum. In Atlantic and Gulf Coast ports the actual receipts of California petroleum alone for this year will probably total 70 to 75 million barrels, most of it from the port of Los Angeles, which in 1923 has become the world's greatest export center for crude oil, even surpassing Tampico in Mexico. This tremendous traffic in petroleum from the Pacific to the Atlantic has resulted in a doubling in the toll receipts, being nearly \$5,200,000 during the 2½ months of the fiscal year 1924 which ran from July 1, to Sept. 15, 1923, compared with the same period a year ago.



PART OF SAN PEDRO—HARBOR OF LOS ANGELES—WORLD'S GREATEST OIL PORT, 1923.

—Among Ourselves, July, 1923.

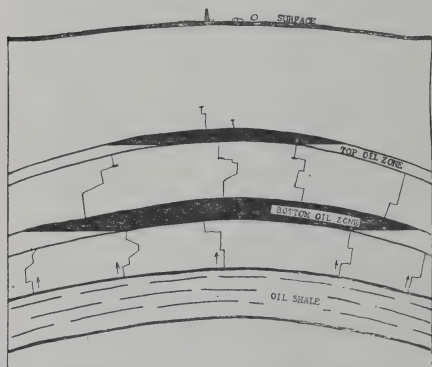
This is probably the most important artificial seaport in the United States. It is located about 90 miles northwest of the natural and noted "Harbor of the Sun" at San Diego, and about 25 miles from the center of the "City of the Angels," which is now the largest American city west of St. Louis. San Pedro is closer to its tributary oil fields than Tampico, Mexico, which ruled until recently as the queen of oil ports. In the background appears San Pedro hill, nearly 1,500 feet high and with terraces to mark its emergence from the ocean during its island days. In the foreground is visible only a part of the Standard Oil Company's "terminal" which altogether has a capacity to load tankers at 30,000 bbls. an hour, said to be the fastest loading rate in the world. See map of the Los Angeles basin on page 35.

CHAPTER II. THE NATURAL RESOURCE.

Nature and Origin of Oil. Crude petroleum is a liquid bitumen—a complex mixture of many compounds, principally those of carbon and hydrogen. It is extremely variable in weight, color, and thickness or viscosity. In general it ranges in specific gravity from 0.75 to 0.99*—that is, it is lighter than water. Some of it has a light color and may be very mobile; some, an almost black color and may be very viscid. Petroleums are commonly divided into two groups, one of oils having a paraffin base and the other of those having an asphaltic base. Usually the oils that have a paraffin base are lighter and contain more gasoline and more lubricating oil and are therefore worth more than the others.

Natural hydrocarbons are present in all sedimentary rocks of marine origin that are not too much altered or metamorphosed. While they are also stored in sediments of fresh-water origin, no valuable deposits in such

have so far been found. The greatest amount occurs in disseminated condition in the shales, especially in the fossiliferous black shales where oil forms as much as 21 per cent of the rock mass. As little as three per cent can be extracted by heating the shales and driving off the crude oil. Impure limestones, notably dark ones, are full of oil, evidenced by the odor on breaking the rock. Even if a series of 1,500 feet thick had but 1 part petroleum in 100,000 parts (of bed rock), this amount would yield 750,000 barrels to the square mile, about equal to the greatest actual production per square mile



SECTION OF AN ANTICLINE

By way of cracks or joints the oil migrates from the mother shale up into porous "sands."

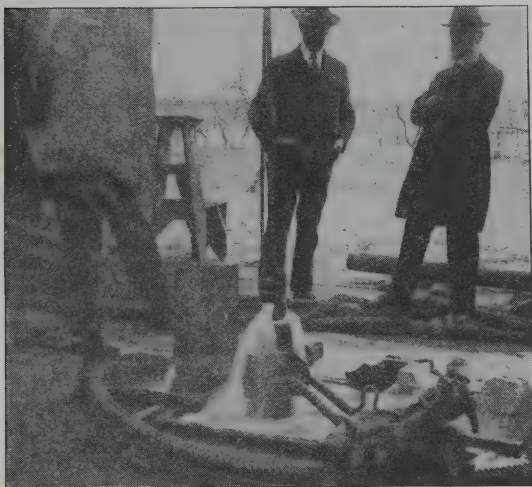
of any part of the leading Appalachian fields. But if the material is to be commercially valuable, it must be concentrated by natural agencies into limited underground areas. Furthermore, to be of use to man, these invisible reservoirs must be discovered by drilling. The natural hydrocarbons occur in the sedimentaries in all conditions from natural gas through light oil and heavy oil into asphalt.

Three theories ascribe an inorganic origin to oil, namely the carbide, the volcanic, and the sedimentary theories. Of six organic theories two claim animal origin. The explanation usually accepted is that oil is formed from the same material as coal, that is, mainly from vegetal matter. Plants, except for the water in them, consist principally of the same elements that go to make up petroleum and natural gas.†

*On the Baume light scale the range is from 56 degrees for the lightest to 11 degrees for the heaviest crude, 10 degrees B. corresponding to the specific gravity 1.00, of water.

†"World Atlas of Commercial Geology," U. S. Geological Survey, 1921.

The material from which petroleum originated was first laid down on the floor of the sea; the greater part of it was seaweed, with some animal tissues which become deposited in connection with fragments of coral and broken sea shells forming beds of limestone. In some rocks of this kind the odor may still be noted in freshly-broken pieces; so marked is the smell that they are known as stink stone. Masses of clay washed down opposite river mouths are heavily charged with fibers and tissues which high pressure reduces into oil and gas. Such carries vast amounts of plant remains. When this is deeply buried under the pressure of other deposits Nature distills it slowly into oil which, separating by gravity from the gas and the salt water, accumulates with these in porous beds; with the



WATER IS ESSENTIAL
TO FLOAT THE OIL TO
THE HIGH PART OF
CERTAIN STRUC-
TURES.

Here is shown a heavy flow of salt water near a large untested Texas structure once leased by the author. This well was drilled 7 or 8 miles from the apparent center or geologic high point and thus missed the oil itself.

gas above and the water below. Overlying impervious strata prevent the upward escape of the oil; and the subsequent movements of the earth's crust, such as bending or breaking, create structures for the natural trapping or storage of the oil until the impervious beds have been punctured by the drill. If the pressure of either the water or the gas is great enough gushers or flowing wells will result when the petroliferous stratum has been penetrated.*

Briefly, the purely animal theory is now definitely on its defensive, the rival vegetal theory having decidedly gained ground especially among the younger generation of practical geologists and those who are intimately associated with the winning of the precious fluid.†

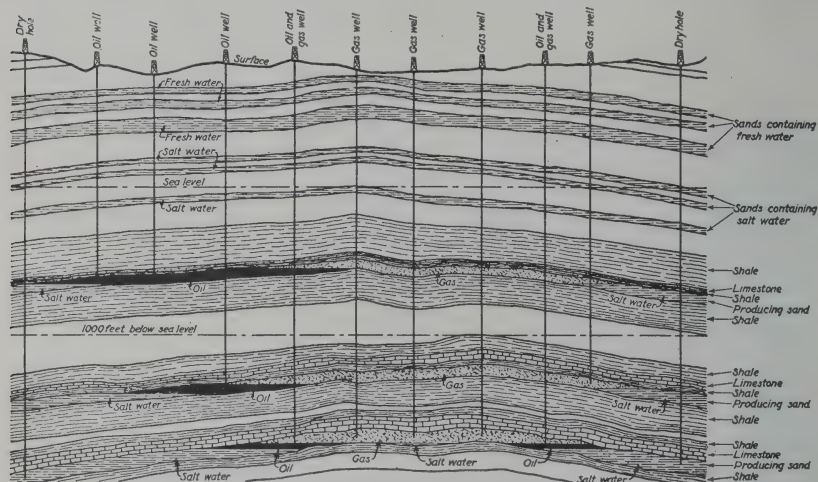
Occurrence in Geological Structures. The world's petroleum comes from sedimentary beds, almost entirely from sands, sandstones, conglomerates, and porous limestones. The deposits are universally held in by coverings of shale, clay, or marl. The bodies of strata most common in oil fields are those in which thick shales, clays, or marls alternate with relatively thin sands.‡

* "Surface Marks of Oil Deposits," P. H. Pearson.

† "Oil-Finding," E. H. Cunningham-Craig, 1920.

‡ "Geology of Petroleum," W. H. Emmons, McGraw-Hill Book Co.

Any arrangement of the beds to form a trap for the gathering of oil in commercial quantity, is called a "structure." Some structures completely trap or enclose the oil within a part of the porous bed, i. e., they are more or less closed. They include domes, anticlines (or elongated domes), and lenticular sands. The domes may be formed by the ordinary "blistering" of the earth's crust, by the underground growth of thick salt lenses, or by the upthrust about a volcanic plug. Local structural highs and sealed



GENERALIZED CROSS SECTION THROUGH AN OIL AND GAS FIELD

—Bureau of Mines, Natural Gas Manual.

faults may hold the oil along the anticlines. Of less importance are the retardation structures on monoclines of moderate dip, i. e., strata gently inclined in one direction only. The retardation may be due to local horizontality or terracing, to mere change in the rate of dip, or to the development of anticlinal noses.

Experience has shown that each oil field has a characteristic and distinctive geological structure. The following classification of American fields is based on structure:

I. Fields with folded structure (anticlines and synclines)—the Appalachian f., Illinois, the Mid-Continent f. (Oklahoma—Kansas N. Texas), N. Louisiana, California, Wyoming, Colorado.

II. Fields with monoclinial dip (homoclines)—Ohio-Indiana; of minor importance in California and Wyoming.

III. Fields on domes—Wyoming, Ohio, Louisiana-Texas Gulf Coast, Mexico.

IV. Fields on faults—California and Wyoming (of minor importance).

V. Fields on unconformities—California, Oklahoma, New York, Ontario, Quebec; of minor importance in Wyoming.*

Petroleum occurs in synclines or "down-folds" only in the absence of (salt) water from the containing stratum.

* Ziegler's "Popular Oil Geology," 1920. At Mexia, Powell and Luling, Texas, faulting is admittedly the major factor in trapping the oil. The great pools of Mexico are located in areas with fault systems.



TWO EXTREMES IN SURFACE SIGNS.

1. Natural gas discovered in a shallow well drilled for water—near and north of the Virgelle structure, 15 miles SW of Big Sandy, Mont.

—Photo by the author.

2. Asphaltic residue or "brea" that remains after the oil exudes from the sandstone and partly evaporates. Under the California sun the "brea" flows in ropy forms and cascades over the edge of a Tertiary bed.

—Photo by R. E. Vandruff.



—U. S. Geol. Survey.

OIL SEEPAGE NEAR HEAD OF KATALLA SLOUGH, ALASKA.

Note the gas bubbles breaking in the surface of the residual oil.

The Carbon Ratios of Coals in Relation to Oil Fields. As regards the alteration or metamorphosis of rock originally oil-bearing a discovery of great practical value was made less than a decade ago by David White, of the Geological Survey. Petroleum in reservoirs associated with the coals show differences corresponding to the degree of alterations of the coals. In the few regions where the geographic association of oil with coal exists closely, almost always with the oil beds (stratigraphically) lower, it has been found that the percentage of fixed carbon in the coal amounting to 65 or more precludes the possibility of commercial deposits of either oil or gas. Where the coals range from 60 to 65 per cent gas may be found but no oil of consequence. Where the fixed carbon ratio runs from 55 to 60, both are found in abundance. These rules apparently apply to Arkansas, Oklahoma, Pennsylvania, Texas, Wyoming and several other states that produce both coal and petroleum.*

Surface Signs of Oil Deposits. The presence of petroleum in any region may be indicated by oil springs or seepages or by surface deposits of asphalt or paraffin wax, and its location underground may be inferred from visible stratigraphic and structural features favorable to its accumulation.

Seepage is the surest evidence of the presence of oil. Most of the Tertiary oil fields of the world are located where seeps occur. Seepage has given the discoverer the first and often the only clue to the oil value of the field. This and structure combined form conditions that delight the heart of the driller, as largely eliminating chances of failure. The fields of Mexico are located in extensive areas of exudation. The great Bibi-Eibat fields of Russia were first operated amidst such visible signs. Development in California mainly followed seepages. In Burma, Galicia, and Roumania, surface marks showed the way. In the Mid-Continent field, however, oil springs are rather rare. The reason is that the beds are so slightly tilted that they remain unbroken and there are no fissures along which the oil can reach the surface in noticeable quantity. Though seepage and asphalt show that oil has been lost we have reason to believe there is more where it came from.†

Geological Distribution. Nearly all the oil produced in Europe, Asia, Africa, and Oceanica is obtained from Tertiary strata. In Canada oil is obtained from Silurian and Devonian rocks, and in Mexico, the West Indies, and South America from Cretaceous and Tertiary rocks. In the United States, which alone supplies two-thirds of the world's output, and in which the scientific quest for it has included the entire stratigraphic column, petroleum is found in the beds of every geologic system above the Cambrian, though the most productive rocks are in the Devonian, Carboniferous, Cretaceous, and Tertiary systems.‡ The Pennsylvanian,

* "Geology of Petroleum," W. H. Emmons.

† Pearson's "Surface Marks of Oil Deposits." Seepages are most in evidence and strongest in those regions where the folding is most recent, and where stresses are still in operation; regions of early buckling furnish little evidence of seepages such as oil or gas springs or asphalt deposits. Such former deposits may have been eroded. The readiness with which seepages are healed is apt to be underestimated; they tend to stop themselves.—David White, Chief Geologist, U. S. Geological Survey.

‡ World Atlas of Commercial Geology, U. S. G. S., 1921.

PRINCIPAL DIVISIONS OF GEOLOGIC TIME, MODIFIED FROM THE
U. S. GEOLOGICAL SURVEY

Era.	Period.	Epoch.	Characteristic life.	Duration variously estimated.
Cenozoic (recent life).	Quaternary.	Recent. Pleistocene.	"Age of man." Animals and plants of modern types during Great Ice Age.	1 to 5 million years.
	Tertiary.	Pliocene. Miocene. Oligocene. Eocene.	"Age of mammals." Possible first appearance of man. Rise and development of highest orders of plants.	
Mesozoic (intermediate life).	Cretaceous.		"Age of reptiles." Rise and culmination of huge land reptiles (dinosaurs), of coiled shellfish with complex partitions (ammonites) and of great flying reptiles. Appearance (in Jurassic) of birds and mammals; of cycads, an order of palmlike plants (in Triassic); and of angiosperms such as palms and hardwood trees (in cretaceous).	4 to 10 million years.
	Jurassic.			
	Triassic.			
Paleozoic (old life).	Carboniferous.	Permian.	"Age of amphibians." Dominance of club mosses (lycopods) and plants of horsetail and fern types. Primitive flowering plants and earliest cone-bearing trees. Beginnings of backboneed land animals. Insects. Animals with nautilus-like coiled shells (ammonites) and sharks abundant.	17 to 25 million years.
		Pennsylvanian.		
		Mississippian.		
	Devonian.		"Age of fishes." Shellfish (mollusks) also abundant. Rise of amphibians and land plants.	
	Silurian.		Shell-forming sea animals ruling, notably relatives of the nautilus (cephalopods). Rise and culmination of the animals known as sea lilies (crinoids) and of giant scorpion-like crustaceans. Rise of fishes and of reef-building corals.	
	Ordovician.		Shell-forming sea animals abound, notably cephalopods and brachiopods. Culmination of buglike crustaceans, the trilobites. First trace of insects.	
	Cambrian.		Trilobites and brachiopods most characteristic. Seaweeds (algæ) abundant. No trace of land animals found.	
	Algonkian.		First life that has left distinct record. Crustaceans, brachiopods, and seaweeds.	
Proterozoic, (primordial life).	Archean.	Crystalline rocks.	No fossils found.	50+ million years.

the upper division of the Carboniferous system, has proven to be the most prolific series of oil-bearing formations in the Mid-Continent field; while the Mississippian, the lower division, prevails east of the Mississippi.

The following summary of **stratigraphic distribution** of oil (and gas fields) in North America covers the important systems of strata according to past production and is brought up-to-date. Where several systems are represented in one state the name of the state is capitalized to show the leading occurrences. (Modified from Ziegler's "Popular Oil Geology".)

Tertiary: CALIFORNIA, Gulf Coast of TEXAS, Louisiana, and MEXICO.

Cretaceous: California (COLORADO), LOUISIANA (Haynesville, Homer, Caddo, Bull Bayou), Mexico, MONTANA, TEXAS (Mexia, Corsicana-Powell), WYOMING (Salt Creek).

(Permian): Oklahoma, North Texas (Burkburnett in part).

Pennsylvania: Illinois (in all parts), Indiana, KANSAS, Kentucky, Ohio, Oklahoma, Pennsylvania, North and Central TEXAS (Burkburnett, Stephens Co., Ranger, Pioneer, Electra), Wyoming (Lander).

Mississippian: ILLINOIS, INDIANA, KENTUCKY, OHIO, PENNSYLVANIA, WEST VIRGINIA.

Devonian: OHIO, (ONTARIO, CAN.), NEW YORK, PENNSYLVANIA, WEST VIRGINIA.

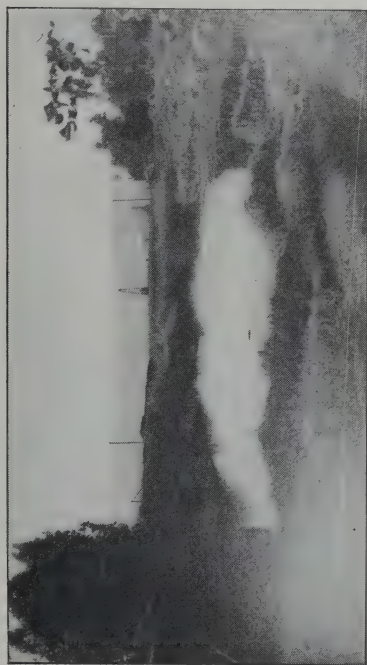
Silurian: New York, (Ontario, Can.).

Ordovician: OHIO-INDIANA (Lima-Ind. field), Kentucky, New York (Ontario).

Of relative unimportance are the Cambrian below the Ordovician and the Quaternary above the Tertiary. The oldest oil-bearing beds occur in New Brunswick and New Foundland, and the youngest in California and the Gulf Coast field.

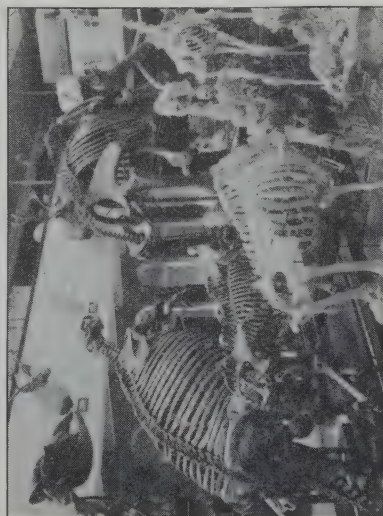
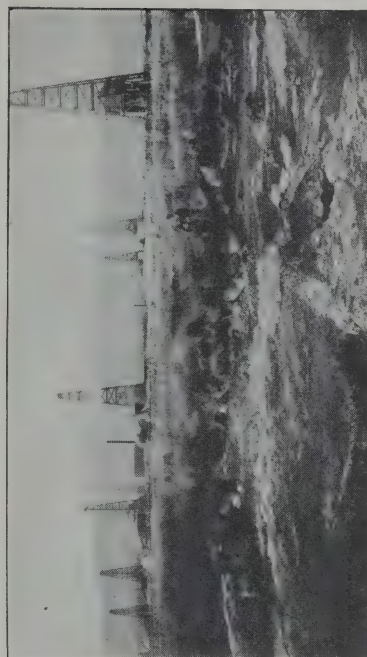
Natural Petroleum Treasures and Tragedies. Mention has already been made of the extinct animals whose buried bones were discovered about 15 years ago in asphalt beds of the Sherman or Salt Lake oil field located on the western edge of Los Angeles. One of the illustrations herewith shows the Imperial elephant, the giant sloth, and skulls of sabre-tooth tigers. Visitors to the American Museum of Natural History in New York City will find there a splendid group of two tigers caught in the natural trap of sticky oil and asphalt, to which, like the giant wolf spectator, they were attracted by the bulky bait in the form of ground-sloths. The greatest collection, comprising over 10,000 individual birds and mammals dug out from Rancho La Brea, are housed in the Museum of Science, History and Art at Los Angeles; and those that are mounted must always prove of great interest to all persons connected in any way with the petroleum industry. A similar find has been recently made in the San Joaquin Valley, also near oil wells, but its extent has not yet been determined.*

* Tragedies in Nature traceable to petroleum are not confined to the land by any means. According to the Oil Paint and Drug Reporter of October, 1922, nations are being called together to prevent the pollution of waters of the earth through the discharge of waste petroleum thereupon. Righteous indignation has been voiced in the sportsmen's circles of Great Britain particularly at the alleged destruction of famed fishing streams by the drainage thereof of oil from highways. The tragedy that befalls the larvae of the mischievous mosquito when kerosene or the cheaper crude oil is used to form a film on the water surface becomes a treasured protection to the health and comfort of mankind in many malarial regions.



THE SALT LAKE OIL FIELD AND RANCHO LA BREA ON WESTERN EDGE OF LOS ANGELES

Note pool of heavy, sticky oil, with gas bubbles bursting as in ancient trap; and 20-acre diggings where extinct animals were found.
—Courtesy U. S. Geological Survey.



MUSEUM VIEWS OF PRE-HISTORIC ANIMALS FROM RANCHO LA BREA

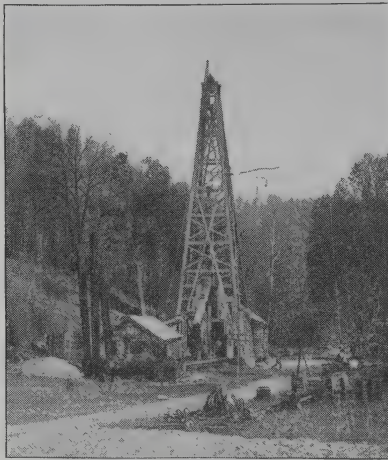
At left: head of extinct Camel, 4-ton Giant Sloth, Great Buffalo, and Imperial Elephant—all tar-stained—alongside modern Camel and Giraffe with bleached bones. At right: Mastodon in front of Imperial Elephant. This mammal stood 2 feet taller than Jumbo and had tusks 14 feet long. Note skulls of Sabre-tooth Tigers, inverted in floor case.

—Photos by the Author.



NATURE'S TRAGEDIES OF LONG AGO MAKE SCIENTIFIC TREASURES OF TODAY.

In connection with geological investigations made at great depths or before the development of an oil field, district, or pool, not only is science enriched but unexpected and valuable discoveries of coal, potash, sulphur, and other economic minerals are made.



ONCE THE
WORLD'S DEEPEST OIL TEST.
Near Bridgeport, W. Va.

As an example of scientific treasure, there is given below the geological record or summarized log of the world's deepest wells. This test was sunk by the Hope Natural Gas Co. on the Goff farm near Bridgeport, Harrison Co., West Virginia, in an effort to reach the "Clinton" oil and gas zone of Ohio. It was begun April 19, 1916, and finished March 4, 1918, to 7,386 feet without reaching the desired depth because the cable parted 2,000 feet above the bottom. In the table, the depth to the base of each series or system starts from the bottom of the Pittsburgh coal seam (lower end of the Monongahela series), an assumed level of 200 feet above the derrick floor.

Name of Bed or Formation	Thickness Feet	Series	Depth
Conemaugh Sand	600.	Pennsylvanian	1150
Allegheny Coal-Bearing Formation	290		
Pottsville Coal-bearing formation	260		
Mauch Chunk	260		
Mountain (Greenbrier) limestone	65	Mississippian	1740
"Big Injun" Squaw, and Berea sand group.....	265		
Catskill (Venango) sand gr. to base of Bayard.	770		
Chemung Shales (Elizabeth, Speechly, Bradford & Kane sand horizons)	2,190	Upper Devonian Shales	7563
Portage Beds	1,207		
Genesee Slate	288		
Hamilton and Marcellus	1,368		
Corniferous limestone to bottom	23	(Grand Total)	7586

According to State Geologist I. C. White, the **temperature** readings in Fahrenheit degrees were as follows:

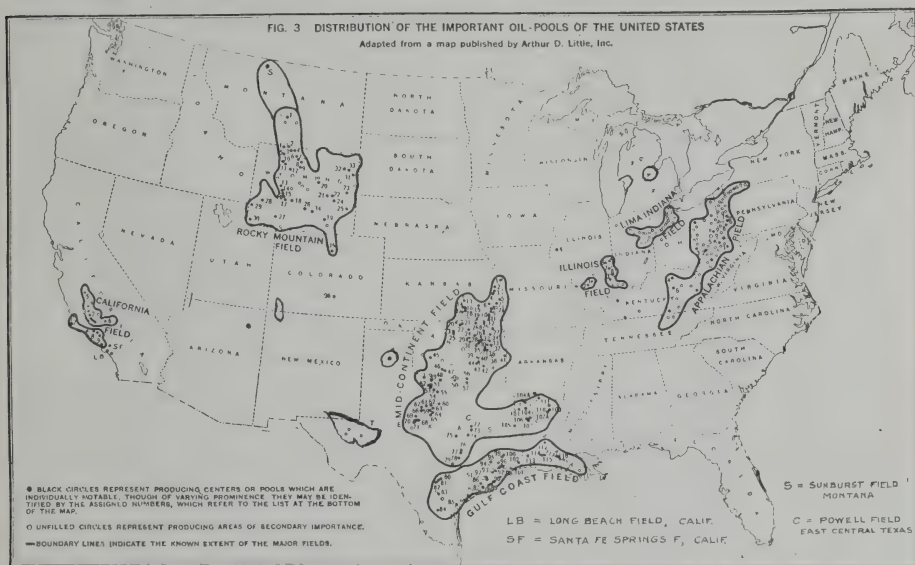
Depth	Temp.	Depth	Temp.	Depth	Temp.
100 ft.	55.6	2000 ft.	74.9	5000 ft.	114.2
500 ft.	60.2	2500 ft.	81.0	6000 ft.	132.1
1000 ft.	65.3	3000 ft.	87.6	7000 ft.	153.2
1500 ft.	67.8	4000 ft.	100.0	7310 ft.	156.3

Potash salts form the basis of the most important **economic treasures** discovered incidentally to the drilling for oil. They were found in the Staked Plains region of Texas by scientists of the U. S. Geological Survey and the Texas Bureau of Geology and Technology operating under Director Udden of the latter. Potash is one of the few essential mineral substances in which our country has not been self-sufficient so far. Unscrupulous promoters have already seized upon its agricultural and industrial importance; and warnings have been issued by the United States Geological Survey to prospective potash investors regarding the exaggerated claims set forth as to the thicknesses of these deposits. Rarer even than potash are the medicinal ichthyol and the non-burning and inert helium. The former is found in mineral oils from California and Texas; the latter as part of the natural gas emanating from petroleum in limited localities of Kansas and Texas.

CHAPTER III. COMMERCIAL GEOLOGY OF MAJOR AMERICAN FIELDS*

Petroleum is as widely distributed geographically as geologically.

The largest physiographic province of the United States, namely, the Interior Plains, was the source of more than 50 per cent of the oil produced during 1922. This province takes in the Appalachian field in the plateau of the same name, the Lima-Indiana field of Ohio and Indiana, the Illinois-Indiana field, and practically all of the Mid-Continent field, the Sabine uplift being (geographically) included with the Gulf Coast field in the Coastal Plain. The Rocky Mountain element comprises the fields of Colorado, Wyoming, and Montana. The California valley and Coast Range embrace the fields of southern California.



—Courtesy of Wiley & Son, Inc., publishers of Pogue's "Economics of Petroleum."

THE SEVEN MAJOR OIL FIELDS OF THE UNITED STATES.

There are many new pools not shown by the dots on this map, particularly in Oklahoma. Within the limits of the outlines of each field lie large dry areas and larger untested areas. Additional prospective oil territory is shown on a map in *The Literary Digest*, Nov. 10, 1923.

The Mid-Continent Field. Commercial usage, largely determined by the quality of the oils, has added the pools of Arkansas and North Louisiana to the **Mid-Continent** field proper. The main oil areas of this field are situated in a broad belt extending from Kansas City south through eastern Kansas and northeastern Oklahoma, thence southwest through

*Based largely upon two Government publications: (1) "World Atlas of Commercial Geology," part I, by J. B. Umpleby and others, issued in 1921 and for sale at \$2.00 by the Director, U. S. Geological Survey; and (2) "Manual for the Oil and Gas Industry," revised in 1921 by A. H. Pay, O. H. Reinhold, and other valuation engineers of the Treasury Department and for sale at 25 cents by the Superintendent of Documents, Washington, D. C. A. C. Bedford recently wrote in *Foreign Affairs*: "Petroleum is the most uncertain of natural resources. Broadly speaking, it is impossible to tell today where oil will be found tomorrow, and having been found, exactly how long the supply will last."



PART OF TONKAWA—ONE OF THE INNUMERABLE POOLS IN THE MIDCONTINENT FIELD.

Discovered in the summer of 1921, it is the first large flush field ever developed with adequate pipe line facilities. At the left appears the cemetery which operators sought to lease. During a week in May, 1923, it produced at the daily rate of 114,061 barrels, dropping to less than 50,000 barrels in November. It is still the most productive high-grade pool, its peak record having surpassed that of the Bradford pool in McKean Co., Pa.

—The Oil Weekly.



PART OF YOUNG COUNTY, TEXAS, WHERE THE STATE HAS LEASED THE BED OF THE BRAZOS.

This shows the Herron Pool in the Bunger district, looking westward. Note the even sky-line of the Edwards plateau remnants made up of Comanche or Lower Cretaceous beds resting on Carboniferous strata of opposite or northwesterly dip.

south-central Oklahoma into north and central Texas as far as Brown and Limestone counties. It may be extended as far west as the Texas "Panhandle" to take in the Amarillo gas pools in Potter County and the minor oil pools in Carson and Hutchinson counties.

Most of the oil produced in Kansas, Oklahoma, and northern Texas is obtained from beds of sandstone in formations of the Pennsylvanian series. Limestone beds are of much less importance. The "sands" are generally between 25 and 75 feet thick, but range up to 300 feet (at Healdton). In southern Oklahoma some oil comes from the "Red Beds" of the Permian series. The oil found in southern Arkansas, northern Louisiana and central Texas is obtained from structures in sandstones or other porous rocks of the Cretaceous and Tertiary systems. In the Mid-Continent field the oil gathered in anticlines, domes, and terraces throughout an extensive region where the strata have a general westerly dip. The depth to production varies from 200 to 3,500 feet, the shallow wells being along the eastern edge of the belt and the deeper wells being confined to the western part. The wells are preferably drilled with standard tools, the rotaries being used as a rule only in parts of Texas and in the "Red Beds" of Oklahoma. Drilling and production cost more than in the Eastern states, although less than in Wyoming and parts of California; hence pumping cannot proceed to so low an economic limit as in the Eastern states. Well spacing is from 2 to 10 acres per well. Recovery of oil per acre is generally less than in California and in the Gulf Coast.

Mid-Continent Oil is almost invariably of paraffin base, and the weighted average gravity is about 36 degrees Baumé. It grades in appearance and gravity from the thick, black oil of Smackover and some Louisiana pools with a gravity of about 20 degrees, to the almost colorless product of the so-called "gasoline well" near Cushing, Okla., with a reported gravity above 55 degrees. The usual gravity range, however, is from 30 degrees to 45 degrees Baumé and the prevailing color is light green. The world's most productive light oil field is Tonkawa, in Kay and Noble counties, Oklahoma, where the average gravity is 43 degrees.

The Mid-Continent field is more pre-eminent in production than in reserves. During the past few years it has been yielding about half of the oil produced in the United States; but on January 1, 1924, it holds hardly one-third of the total reserves.

The California field may be divided into 3 geographic sub-provinces. One covers both sides of the San Joaquin valley and is known as the Valley "fields" or districts; another takes in the many small and separate districts in the mountainous Santa Barbara and Ventura counties; and the third comprises the districts of the southern coastal plain in Los Angeles and Orange counties. Except for the Kern River pool the Valley districts lie on the west side of the valley and all get the oil mostly from Tertiary sandstones that have been folded. Sharp anticlines constitute the controlling type of structure, yet much oil has come from monoclines and synclines. Similar in many respects are the Coastal districts although displaying an even greater variety of structures, but sealed faults are fewer. An insignificant part of the California petroleum is obtained from Cretaceous formations. Compared with the Gulf Coast field of Texas much less oil has migrated from the Tertiary up into the Quarternary beds. A



—Oil and Gas Journal.

1. (Above) A KERN COUNTY FIELD
IN SAN JOAQUIN VALLEY, CALIF.

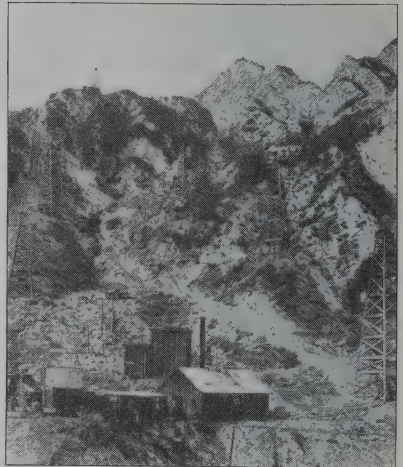
Note the open "oil duct" for carrying the heavy oil down grade more easily than in pipe line.

2. AN OIL FIELD IN THE COAST
RANGES OF CALIFORNIA, VEN-
TURA COUNTY.

The topography and the political division suggest "nothing venture, nothing have," a rule in oil hunting.

3. HUNTINGTON FIELD IN THE
COASTAL PLAIN.

View of a young field from the ocean. It is generally regarded as within the Los Angeles basin.

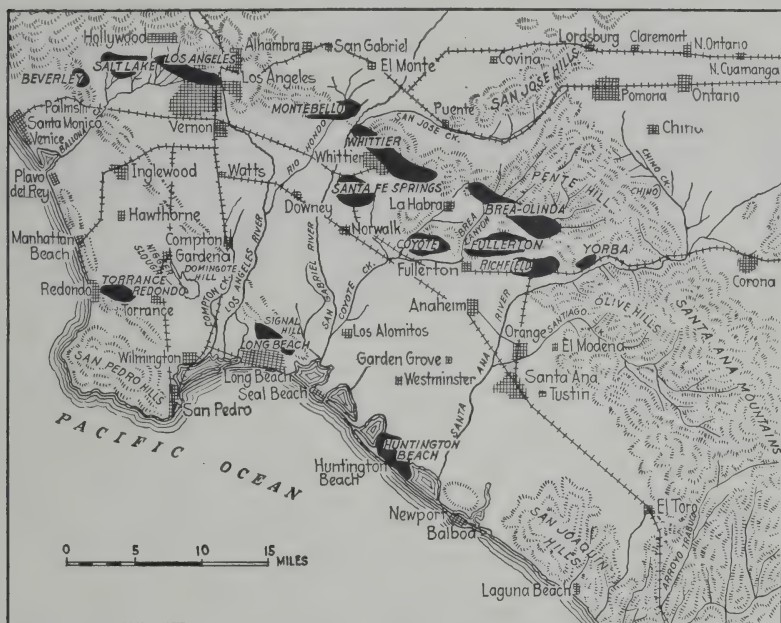


—U. S. Geol. Survey.



—Calif. Chamber of Mines and Oil.

marked feature of the California occurrences is the great stratigraphic range throughout all the four series of the Tertiary system which, in the Sunset-Midway district becomes 18,000 feet thick. Producing horizons appear anywhere from 300 to over 5,000 feet below the surface. Oil seeps are numerous, and asphalt beds cover wide areas. In no other region in North America is oil found in commercial quantities where the structure is so complicated and where the surface indications are so abundant. The California oils vary in color from black to honey-yellow and in gravity from 9.9 degrees to 54 degrees Baumé, the average having recently risen from 22 degrees to 28 degrees. Heavy dark oils predominated until the light oil pools were developed near Los Angeles, 1921-1923.



Am. Inst. Min. and Met. Engrs.

LOS ANGELES BASIN SHOWING OIL FIELDS, 1923

Near the middle of this map is seen California's greatest individual field, Santa Fe Springs, which reached a record of 350,000 bbls. daily during the summer. In November, Long Beach or Signal Hill, 10 miles southwest, passed the champion on its decline but reached a peak of hardly 275,000 bbls. daily, 50,000 less than Powell in Texas. The newest pool, not outlined here, is Compton—halfway between Santa Fe Springs and Torrance-Redondo. (Map drawn by Wayne Loel.)

"The most striking features in the three newly discovered fields in the Los Angeles basin are the enormous thickness of oil sand"* and the limited producing area from which are coming 23 per cent of the country's petroleum at the present time, May-June, 1923. At Long Beach a thickness of over 1,500 feet has been penetrated to the depth of a mile. At Santa Fe Springs the oil sand is said to be even a little thicker, and at Huntington Beach certainly not any less, the horizon being the same in all three of these fields. California's total oil-bearing area is considered to be

*Ralph Arnold and Wayne Loel in *Mining and Metallurgy*, May, 1923.

about 1,500 square miles,* or nearly 1 per cent of the area of the state. Out of this, practically one-tenth only has been proven or is at present productive. About 30 square miles, or 20 per cent of the proven area, lies in Los Angeles and Orange counties which contain the above named new fields. These three together cover but 5,300 acres or less than 9 square miles, but they were in June, 1923, contributing at a rate equivalent to one-sixth of the world's total.



—Oil and Gas Journal.

THE FIRST POOL FOUND IN THE GULF COAST FIELD.

Spindletop, near Beaumont, Texas, was discovered January 10, 1901, and became the leading pool of the United States in 1902. It has produced about 50 million barrels and is still active. See Chap. IV.

The Gulf Coast field of Texas and Louisiana ranks third in respect to reserves, possessing 20 per cent as of January 1, 1924. Moreover, its present rate of production, 5 per cent of that of the whole country at the middle of 1923, places it far below California. This field includes that part of the Gulf Coastal Plain in which petroleum is associated with masses of rock salt and gypsum in domes. The oil-bearing strata are Cretaceous to Quaternary in age, and the reservoir rock is generally either sandstone or dolomitic limestone. In this coastal belt rise more than 40 low domes above the general level. They are supposed to be the surface marks of the salt domes which are beneath and which are known to produce some oil or gas. Few of the pools are more than 3 miles in diameter. The reservoir rock is generally either sandstone or dolomitic limestone, and the oil itself has an asphaltic base. The value of some of the oil is impaired by its high sulphur content—up to 2.3 per cent. The gravity ranges from 15 degrees to 32 degrees, averaging 22.5 degrees, Baumé. Most of the oil is dark brown to black, but some is green and rich in lubricating constituent. Any relation between color, gravity, and content of sulphur is not apparent. The zones of production vary from a few feet to hundreds in thickness and from 100 to 4,100 feet in depth. The rotary drill is used almost exclusively and consequently the correlation of the various sands is difficult.

The Rocky Mountain field comprises all areas that produce petroleum in Colorado, Wyoming, and Montana, as well as some areas of prospective production in Utah and New Mexico. The oil is derived from beds of Pennsylvania, Permian, Triassic, and Cretaceous age. Most of the oils

* State Mining Bureau, quoted in *The Oil Weekly*, June 17, 1922.

**V. B. Ellzey in *The Oil Weekly*, May 12, 1923.

from pre-Cretaceous beds are dark and heavy, with gravities averaging 23 degrees Baumé, the heaviest being of 11 degrees. The Cretaceous oils, contrary to expectation, are remarkably light in both color and weight. Their gravity ranges from 25 degrees to 50 degrees Baumé, while the average gravity for the Rocky Mountain field is about 37.5 degrees. Worthy of special mention is the Cat Creek oil from Montana. It has a paraffin base, contains little sulphur, and is 8 degrees lighter than the average Appalachian oil or 13 degrees lighter than the average Mid-Continent oil. Its gasoline content is $1\frac{1}{2}$ times that of Appalachian oil and twice that of Mid-Continent oil. No other pool in the United States of the same size as the Cat Creek yields such a quality of crude product. The Rocky Mountain reserves as of January 1, 1922, were estimated to be



—Photo by the Author, Sept., '23.

THE LARGEST OF THE ROCKY MOUNTAIN FIELDS IN AREA.

The Kevin-Sunburst Pool, found in the spring of 1922 by Gordon Campbell, is again referred to in Chapter VI.

about $7\frac{1}{2}$ per cent of all our American reserves, Wyoming alone being credited with 6 per cent. The rate of production on July 1, 1922, equaled 5.6 per cent of that for the whole country. Since the discovery and initial development of the Kevin-Sunburst field, probably the largest single American pool in point of area, the estimate of oil reserves has been raised so as to make nine per cent of the total.

The Appalachian field still retains underground almost 1 billion barrels or eight per cent of our total reserves after producing about $1\frac{1}{3}$ billion barrels in the course of the past 64 years. The present rate of yield is about 4 per cent of that for all the fields. This field embraces every pool east of central Ohio and north of Alabama in an elliptical area having a major axis trending northeast and southwest. Besides southeastern Ohio it includes the petroleum territory of New York, Pennsylvania, West Virginia, Kentucky and Tennessee. The oil-bearing strata are chiefly sandstones and conglomerates of Devonian, Mississippian, and Pennsylvanian age. These porous rocks produce from depths of 100 to 4,000 feet, the shallowest horizons being found in eastern Kentucky and the deepest in West Virginia and southern Pennsylvania. The typical oils are of paraffin base, are free from asphalt and objectionable sulphur, and give up to 79 per cent of kerosene, gasoline and lighter products by ordinary refining. They range in color from black to light amber, but most of them are of green shade. In gravity they run from 25 degrees to 53 degrees Baumé and average 41 degrees.

The Illinois field, confined largely to the southeastern part of the state, with small scattered pools in the central and western parts, ranks 6th in the matter of reserves, having hardly 5 per cent of the 9 billion barrels of oil still obtainable in the United States early in 1922. The present rate of output, about 10 million barrels yearly, would afford a long life to the Illinois field, considered as a whole. Most of the oil comes from sandstone beds in the Pennsylvanian and Mississippian series of the Carboniferous system. The oils in the northern part of the field are heavy, have an asphaltic base, and carry sulphur. Those in the southern part are of better grade. The gravity ranges from 27 degrees to 37 degrees Baumé. The richest area of this field is in Lawrence County, where 7 sands are encountered at depths of 450 to 2,000 feet, with the richest at the bottom.

The **Lima-Indiana** or Trenton field is of least importance from a quantitative standpoint. Its reserves make but $\frac{1}{2}$ of one per cent of our grand total and its recent rate of production makes but half of one per cent of the aggregate rate for the United States. It embraces all the pools in northwestern Ohio and most of those in Indiana. The oil-bearing beds in this field belong to the Ordovician, Silurian and Carboniferous systems, but the most productive are lenses of porous dolomitic rock in the "Trenton" limestone, a member of the Ordovician system and the oldest known oil-bearing rock in the United States. This lies 1000 to 1500 feet deep in Ohio pools and averages 1000 feet in Indiana. The oil from the Carboniferous rocks in southwestern Indiana properly belongs to the Illinois field, for the formations occupy the same structural basin and the two "fields" or districts are continuous. The oil in the pre-Carboniferous strata of the Trenton field is of lower grade than that in the same strata of some parts of the Appalachian fields and contains sulphur compounds that must be removed by special treatment. In color the oils range from green to brown and in gravity they average nearly 36 degrees Baumé.

Canada. Indications of petroleum have been observed in many parts of Canada, but no fields have been much exploited except those in Ontario, where the oil occurs in sandstones and limestones of Silurian and Devonian age, and where the rate of output is now insignificant. The oil there has a paraffin base and a large percentage of sulphur. It comes from a depth of 200 to 500 feet. The Calgary field has furnished a small quantity but a field farther north in Alberta gives greater promise. In the Mackenzie field, during 1920, oil flowed from a depth of 100 feet and gushed from 800 feet. Up to August, 1923, the developments have proven rather disappointing, particularly in the western part. However, continued search may bring results now that new Montana fields have been found close to the Dominion line. Canada's petroleum reserves have been estimated at 2000 million barrels, a comparatively high figure, considering past production, but not inconsistent with the great expanse of favorable formations as yet scarcely scratched with test borings. Fortunately, the more accurately measured coal resources are immense, Alberta alone possessing 17 per cent of the world's known coal or 70 to 80 per cent of Canada's coal deposits.

SUMMARY OF SALIENT FACTS ABOUT THE PETROLEUM RESOURCES OF UNITED STATES

Region or Major Field and States	Proven Area Miles ²	Average Gravity Degrees B.	Yield to Jan. 1, 1924 Millions of Barrels	Recoverable Reserves Jan. 1, 1924 Millions of Barrels	Original Reserves Millions of Barrels
MID-CONTINENT					
Okla., Tex., Ark., Kan., La.....	1,500?	35.9	2,550	3,450	6,000
CALIFORNIA	175	21.9	1,800	2,700	4,500
GULF COAST					
Texas, Louisiana	25?	22.4	470	2,330	2,800
APPALACHIAN					
Pa. and N. Y., O., W. Va., Ky., Tenn.	2,500	40.8	1,380	920	2,300
ROCKY MOUNTAINS	700?	37.5	175	1,025	1,200
Wy., Mont., Colo.					
ILLINOIS-INDIANA	350?	32.5	350	500	850
Ill., S. W. Ind.					
LIMA-INDIANA	500	35.9	430	90	550
N. W. Ohio, N. E. Ind.					
UNITED STATES					
Total Proven	5,750	32.0	7,185	11,015	18,200
Miscellaneous	250?	?	None	800	800
Grand Total	6,000	32.0?	7,185	11,815	19,000

REMARKS. The general areas of production, as shown on generalized maps, are much greater. The actual areas of proven territory take in both producing and undeveloped oil land. They are rather well defined in California and in the Appalachian and Lima-Indiana fields. In roughly determining the Mid-Continent area there were considered the total number of oil wells, their spacing of 6 or 7 acres per well, and the likely percentage of proven but undeveloped acreage. In the case of the Gulf Coast, statistics published in *The Oil Weekly* indicate an area of 5,700 acres for 11 out of the 21 local fields or salt domes that have produced on a commercial scale; and with this as a basis a liberal allowance has been made for the acreage of the other 10 and for the undeveloped areas, the total being likely a little less than 25 square miles—a remarkably limited area for so large a production to 1924. In the Appalachian field there is an additional area of 1,700 square miles of productive gas territory. In other fields their minor areas are included where not separated in the original data.

Gravities given are on the Béume scale. They are all weighted averages, considering the relative yield of different grades within each major field, and were published by the U. S. Geological Survey in October, 1922. The only radical correction to be made is for California, where the average quality of the crude oil was raised to an extraordinary extent within a year's time due to the light oil development of the Long Beach and Santa Fe Springs fields near Los Angeles. The average has risen from 21.9 to fully 28 degrees if not higher. The heavy Smackover oil of Arkansas, strictly not Mid-Continental, has been offset largely by the light Tonkawa oil of Oklahoma.



TANKER IN WAR-TIME PAINT, LOS ANGELES HARBOR

Tankers were largely instrumental in winning the war for the Allies by carrying fuel oil and other products across the Atlantic.

—Courtesy of Union Oil Co., of Calif.

CHAPTER IV. MECHANISM OF THE AMERICAN INDUSTRY.

Engineering Aspects. Next to the natural resource as a foundation for the Oil and Gas Industry stands the development of technologic methods for finding, obtaining, transporting, treating, and utilizing the crude petroleum and natural gas. Were it not for the wonderful work of both the geologist and the engineer-technologist, the one in exploring for new deposits and the other in striving to procure maximum recovery of the crude oil and maximum efficiency in the refining and use of the product at a minimum cost and with a minimum waste, the industry would not have attained to one tenth of its present proportion; and consequently would neither attract millions of investors nor give employment to many thousands of wage earners.*

Since the beginning of the petroleum industry in 1859, up to five or six years ago, there has been a dearth of engineers who have had the fundamental technical training and also sufficient practical experience so that they could compete with purely practical men. About 23 years ago, Captain Anthony F. Lucas, a mining engineer, resorted to the rotary process in drilling an 1100-foot well, and brought in one of the greatest gushers ever found within the United States. The mechanical accomplishment was then overshadowed by his discovery of commercial oil in a Gulf Coast dome which rises but 12 feet above the prairie at Spindle Top, a little south of Beaumont, Texas. Previous to that time almost all American wells were sunk with cable tools. With a few similar exceptions, and "until recently, comparatively little attention had been given by the engineering profession to the petroleum industry except in storage, refining transportation and natural gas."†

Conservation of underground reserves has been initiated by engineers, notably in California where it has been carried on through the co-operative work of the operators with the State Mining Bureau. Along this line of endeavor "it is now universally recognized that the minimum protective work necessary narrows down to two requirements: 1. Excluding water from the production of the well; 2. Preventing the migration of water, outside the casing, from water bearing formations to oil or gas bearing formations." "The proper setting of casing, cementing off water, checking productivity of individual wells, correct plugging of dry and abandoned wells, and various other conservation methods established elsewhere" were in 1918 being adopted in Oklahoma as a direct movement

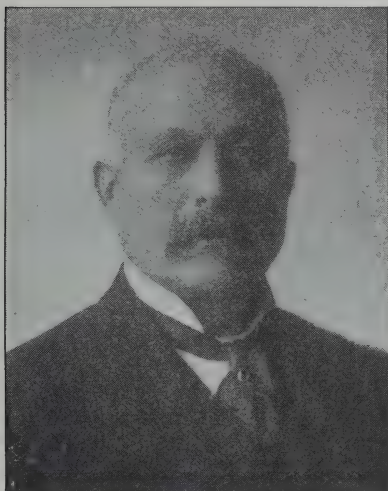
*The president of a large Mid-Continent producer has calculated, from extensive records, that 85 per cent of the wells located on the basis of careful geological surveys proved productive, whereas only 5 per cent of the wells located at random were successful. Pogue's *Economics of Petroleum*, p. 343.

Writes the editor of the *Oil and Gas Journal*: In the oil business in the old days, but slight attention was paid to technical matters. The refiners were obliged, of course, to know things scientific, but the producing men were guided largely by every-day experiences. Main strength plus practical knowledge of the routine work were the essentials then as they still are to a large extent. Nevertheless, there are now opportunities for genuine "efficiency" men in oil producing work. Many of the big concerns are profiting by the skill of technically trained men. In the refining industry the "highbrow" is more in demand than ever before.

† E. W. Wagy, *Pet. Engr.*, Bureau of Mines, in the *Oil and Gas Journal*.

toward the saving of crude oil. The use of cement in oil wells not only conserves the supply of the raw material but it also conserves capital and enhances the profits, as in the case instanced below.

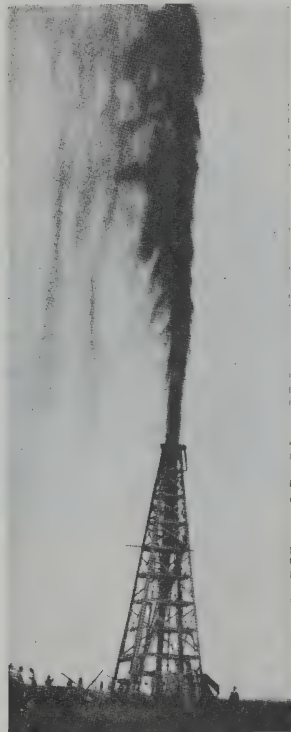
"On 141 wells in the Cushing field that had been put back to producing **after cementing**, there occurred an immediate increase in yield of 4,304 barrels daily. At the quoted market price of \$2.25 a barrel (in



CAPT. ANTHONY F. LUCAS.

The pioneer of the Gulf coast fields; first to use the rotary for drilling oil wells; and the indirect founder of the first great independent operators, the Gulf and the Texas companies.

At the right is shown the LUCAS GUSHER, greatest oil well ever drilled in the United States. It came in Jan. 10, 1901, at 75,000 to 100,000 barrels a day. Since then the Gulf Coast field has produced about 500 million barrels of oil.



—Courtesy A. F. G. Lucas.

May, 1919) this quantity was equivalent to \$9,684 a day, and at \$3.00, the price at which most of the oil was actually sold, it was equivalent to \$12,912." At that rate the additional production would mean almost \$4,000,000 in one year compared with the probable cost of less than \$75,000 for cementing the 141 wells. Besides the increased yield there was likewise effected a large saving in the labor required, amounting to 40% of that involved before cementing; also a lower rate of deterioration in well equipment due to the absence of salt water.*

Similar results have been accomplished by the U. S. Bureau of Mines in co-operation with the Rocky Mountain Petroleum Association in Wyoming. A well which had been standing full of water was repaired and completely recovered. One month's production therefrom was worth more than the cost of the four men's services for one year. Notwithstanding

*"Recementing Through Tubing Under Pressure," by C. C. Thoms, *California Oil Fields*, July, 1920; and U. S. Oil Inspector's report to the Superintendent for the Five Civilized Tribes of Oklahoma.

the various advances that have been made in the line of enlarging the ultimate recovery from sands, there still remains a very large margin for improvement in view of the serious fact that 80 to 90 per cent of the underground oil is unrecoverable by the prevailing production methods. Profits from the industry will be immensely increased when the relative recovery equals or exceeds the much higher rate of that otherwise backward branch of mining, the under-engineered and over-capitalized coal industry.



—U. S. Geol. Survey.

THE GREATEST FIELD FOUND IN THE UNITED STATES BEFORE 1923.

Only part of the Drumright division of the Cushing pool is shown here with wells along the Cimarron river in Creek Co., about 25 miles west of that other great pool, the Glenn. Cushing, surpassed nationally by Powell and Santa Fe Springs fields alone, was found by W. S. and R. E. Vandruff, geologists and former associates of the author, one year before the first well was drilled in 1912.

In the chronological order of their realization, the three most important and profitable applications of technology in the near and not very distant future pertain to (a) the use of core drills in wild-cattling rather than in developing, (b) the sinking of shafts for the mining or draining of pumped and abandoned sands, and (c) the extraction of oil from the extensive deposits of bituminous shales found in certain Rocky Mountain states and in Kentucky and other Allegheny plateau states. Shale oil has no immediate value and will receive little consideration in this edition.

Production engineers, constituting a new class of petroleum technologists, may soon perfect American methods for mining or draining residual reservoirs in old fields or pools as advocated by Albert H. Fay in the *Oil and Gas Journal*, May 28, 1920. Intrenched in their ignorance, some apparently intelligent operators scorn this idea, claiming it has never been done. As a matter of fact, while shaft-sinking failed in the early boom days at Petroleum Center, Pa., tunnelling for oil was successfully undertaken in California about the same time. Actual mining of petroleum sands was carried on by Frenchmen in Alsace from 1735 to 1865 at depths of 35 to 220 feet. Such operations, on a new principle, were resumed in 1916, with the result that 2 to 5 times as much oil was thus extracted as by the ordinary well-boring process. In Estill County, Ky., during May, 1921, D. W. R. Kinney began sinking a shaft, concrete lined, and on reaching the sand at 135 feet got 4 to 5 barrels of oil a day.

In the meantime, and until mining methods have been adopted, production engineers have resorted to other and temporary expedients to extend the extraction beyond the present limit of 10 to 20 per cent. The compressed air process has spread to some pools and properties where ordinary pumping has reached the economic limit, particularly in the Appalachian field. Some old properties there have been rejuvenated so as to yield, in this way, from one-half to equally as much as the entire past production. Flooding partly exhausted sands with water has also proven satisfactory, as in the Bradford field, Pennsylvania, where this process was initiated in 1890.*



MINING OIL SANDS AT PECHELBRONN, ALSACE, SINCE 1735.

French and German miners sank shafts and drove galleries for 147 years before a well was drilled in 1882 to a depth of 465 feet and gushed 500 barrels daily. (See pages 16 and 72.)—*Rig and Reel Magazine*, Parkersburg, W. Va.

Conservation of capital through core drilling. Out of 750 million dollars lost the last five years through unsuccessful drilling for oil, largely legitimate wild catting at that, at least 250, possibly 500 millions could have been conserved through eliminating the old fashioned, cumbersome, and costly cable and rotary systems and the substituting therefor the more reliable and scientific systems of drilling for exploratory purposes. Sixteen years ago, or four years after introducing core drilling into the Philippines,† the writer advocated the use of diamond drills in testing virgin territory for oil on the Pacific slope. Only during the past five years have the progressive California operators begun to appreciate the various advantages gained by spending a little time and money on coring of one kind or another.

-The more conservative companies have hesitated to abandon entirely their practice of boring a big hole from the very beginning or "spudding in;" and so have tried to adapt the antiquated systems to the cutting of cores out of the strata as occasion required it. The Keystone Drilling Co., of Beaver Falls, Pa., has improvised a device for extracting a short core

*See "Causes of Increase in Yield," Chapter V; also, for technologic details read chapter by L. C. Sands in vol. I, Day's "Handbook of the Petroleum Industry," published by John Wiley & Sons, 432 4th Ave., New York; see also "Eighty Per Cent of Oil Not Recovered," by K. C. Heald, of the National Research Council and U. S. Geological Survey, in *The Oil and Gas Journal*, Oct. 18, 1923.

† See the author's illustrated article on the U. S. Army coal mines in *The Engineering Magazine*, January, 1906; or the *Review of Reviews*, February, 1906.

while operating the ordinary cable tools. In connection with rotary tool drilling for production in the Gulf Coast region one company transformed a piece of common pipe into a combination core-barrel and cutting tool by making chisel teeth at the lower end thereof and bending alternate teeth inwards to hold the core. It cuts like an ordinary post-hole auger. According to R. E. Collom, some companies have been using a coring device in soft formations in which the core barrel is incorporated in the center of a fish-tail bit. Suman states that a certain Gulf Coast driller uses a



--The Engineering Magazine, Jan., 1906.
DIAMOND DRILLING IN THE
PHILIPPINES.

EFFICIENT AND NON-WASTEFUL WAY OF EXPLORING FOR FUEL DEPOSITS.

The first systematic attempt to prospect the mineral resources of the Philippines. This was done at the U. S. Army coal mines where the author served as superintendent of explorations, associated with Major H. L. Wigmore, in 1903-4 while Chief Justice Taft was Governor. Credit is due the progressive Corps of Engineers, U. S. A., for thus introducing a scientific and practical method for finding truth and conserving capital. The first drilling for oil in the Archipelago began a little later, but unfortunately cable tools and not core drills were used. (See Chapter VIII for recent drilling in the Islands.)

piece of common pipe with a V-shaped notch cut in the lower end. Upon rotating this at the bottom of the hole it has cut cores from 8 to 10 feet long, and these became wedged in the barrel by dropping into the drill stem small pieces of cast iron. This last appears to be an independent imitation of the more perfected Okell core drill manufactured in Los Angeles and used by the Shell Company and others in drilling through both hard and soft formations. A contrivance more complicated but easily repaired has been used by van der Gracht for coring in soft formations with rotary tools.

Coring with the regular oil well rotaries in California has not proven altogether satisfactory. The heating of the core barrel through the rapid rotation volatilized or drove out the petroleum (or gas) from the sample entering the core barrel, and the latter, therefore, gave no reaction with ether.* On the whole, drilling systems designed primarily for development or production are neither so economic nor so dependable as the specially designed coring systems of usually smaller caliber but of equal or greater capacity in depth.

Core Drilling in California Oil Wells.† "Core drilling, as practiced in California oil wells, is only for the purpose of taking samples at critical

*The core is sometimes heated so intensely that it becomes hard to tell whether the rock is igneous or sedimentary—a very important matter—for it is a hopeless task to drill for oil in granite or lava.

†By F. C. Merritt, Los Angeles, in *Mining and Metallurgy*, August, 1922. See also "Technique of Core Drilling," by J. E. Elliott, *M. and M.*, October, 1923.

depths. The core drill is not intended to supplant the fish-tail bit in rotary drilling. Sampling by such method is necessitated since accurate well logs cannot be obtained by the rotary method. Oil sands are often obscured by the heavy mud used in rotary drilling, and may be easily penetrated without the driller's knowledge. The hydrostatic pressure of the mud-flush column at times suffices to drive the oil back into the formation so that no evidence of it may be seen at the surface.

Core drills have been evolved in California for the purpose of taking samples at frequent intervals when the expected depth of the oil sand has been reached. Only within the past year has an active campaign of core drilling been carried on in California, but at the present time it is the usual practice of many of the larger companies in the southern California fields to take cores at 10-foot intervals at promising levels.

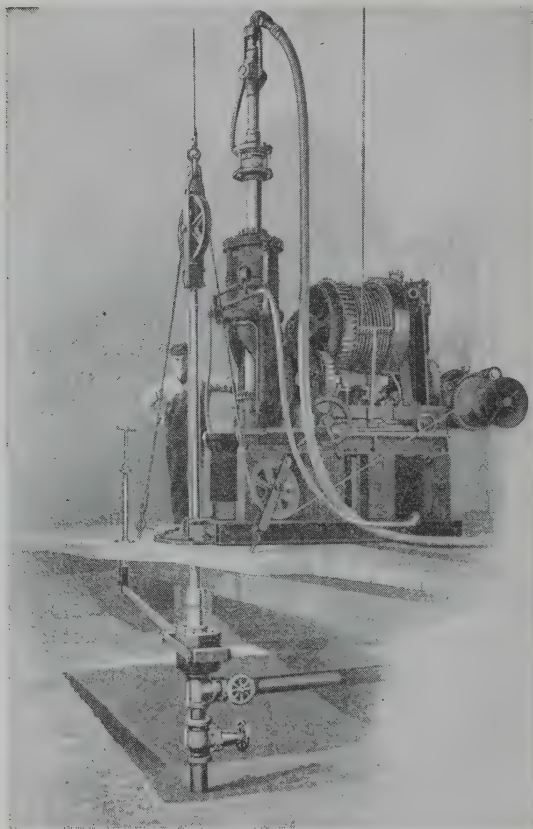
There are two general styles of such core drills in use, the single-barrel drill and the double-barrel drill. The single-barrel drill consists of a length of drill pipe with teeth in one end. This contrivance is rotated in the bottom of the hole, and at the conclusion of coring sufficient weight is given the drill pipe to bend in the teeth. The double-barrel drill consists of two barrels, one within the other, both fitting into a steel shoe equipped with removable teeth. The mud flush passes between the two barrels to the bottom of the hole.

Both types have advantages and disadvantages. The single-barrel drill is cheaply and easily made, but the cores extracted are not always reliable. As the mud flush does not reach the bottom by several feet, the so-called cores cut by the single barrel are often only compressed cuttings. Furthermore, the generated heat is often enough to fuse the material, or at least to change into gas any oil that may be present in the cored material. The double-barrel drill extracts a true core without danger of contamination by the mud flush, and without "burning," but it is more expensive to make and to operate, and requires greater skill from the operator.

Many of the companies are now using a core drill to locate the proper formation in which to cement the water string (of casing), and find that they have a greater percentage of successful water shut-offs by so doing. Geologists study the cores extracted so as to correlate shale strata by their contained micro-organisms. Sand cores are analyzed for their salt and total solubility content. **The oil operator realizes that the core drill is the biggest forward step made in the art of rotary drilling.** He wants to evolve a type of drill that will retain the speed and simplicity of the fish-tail and at the same time preserve an accurate sample of the formations."

OPERATIVE DIVISIONS.

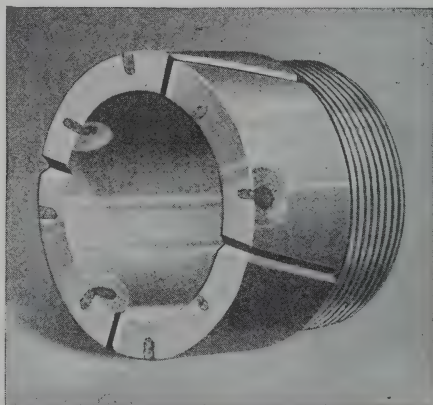
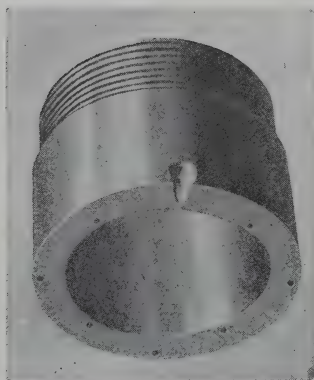
Custom considers the petroleum industry divided into the four distinct functions of production, transportation, manufacturing and marketing from the standpoint of economic organization. Viewed otherwise, there should be added a fifth function, namely **exploration**, the operation of which is almost as peculiar to the oil industry as that of the others. It is gradually outgrowing the production division to which it has hitherto been subordinated. Synonymous already with scientific "wildcatting,"



**BORING FOR PRODUCTION IN MEXICO WITH
A DIAMOND CORE
DRILL.**

A Sullivan "P-2" diamond drill showing pressure control rig, rod brake and a saver of oil. Before 1922 few operators would believe that the diamond drill was good for any purpose except for testing wild-cat territory. In Oklahoma recently a well unfinished with cable tools was completed to a depth of 4,700 feet with a diamond core drill.

—Sullivan Mch. Co.



DIAMOND DRILL BITS BEFORE AND AFTER FULLY SET.

At left the blank bit shows socket chiselled out to fit irregular shape of a carbon or black diamond. Sheet copper is used to help make a snug fit. Clearance or projection on cylindrical face varies from 1-64 to 1-32 of an inch. Water grooves are also shown.

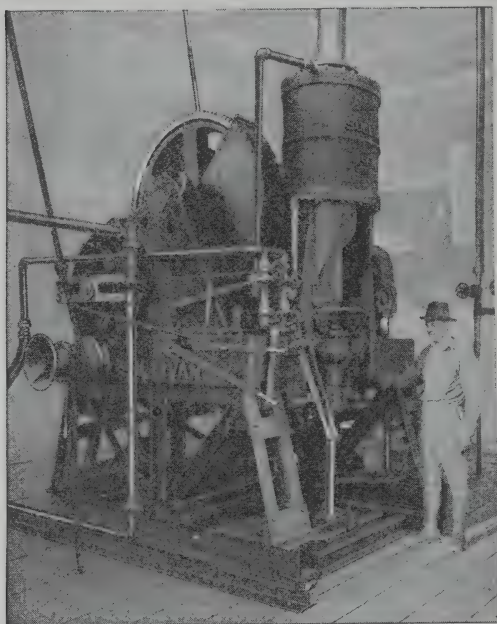
exploration as practiced by the efficient operators is fast coming to mean core drilling in connection with thorough geological investigations of surface signs. Drilling experimental wells—ordinary “wildcatting”—has stood at the base of the discovery of new oil fields without which the industry would have dried up. For every field thus found, hundreds of worthless holes have been put down. Scientific wildcatting will not only minimize the number of resultless borings but will also cut the cost of each test at least in two, particularly in remote regions where transportation, fuel and living conditions are controlling cost factors.

Now that such enormous reserves of coal and ores of iron and copper have been largely measured by means of the diamond core drill the time has come that many of the skilled men and their machines can be released for the even more essential task of discovering new deposits of petroleum so as to maintain if not increase the relatively low ratio between known reserves and current consumption or production.

Exploration with the Diamond Drill. The diamond drill and the rotary oil drill work on the same general principles, the main difference being the cylindrical steel bit set with “carbons” or black diamonds* which is used by the former instead of the fish-tail or other type used by the rotary, as already narrated. On account of the brittleness of the carbon and the danger of breakage if suddenly struck, it is not feasible to attach a diamond bit to the rotary drill stem. The operating mechanism of the diamond drill must be subject to much more sensitive control than the rotary drill. The bit must be rotated smoothly, without the jerks incident to the operation of the clutches and chain drives on the rotary draw works, and the feed must be controlled in a manner much more delicate than the action of a brake on a hoist. Accordingly, diamond drills are usually built as a self-contained unit with the crank shaft of the engine geared direct to the drive shaft that turns the drill rods. One or two hydraulic cylinders connected with a high pressure pump control the feed so definitely that the bit can be raised or lowered at will, while the bit is rotating, by the simple operation of valves. The smaller-sized drills for very shallow work generally have a screw feed control instead of the hydraulic feed; and their portable nature adapt them for outlining structure where key beds lie less than 500 to 600 feet below the surface. The heavier drills are used for scouting, i. e., obtaining data as to the character of the oil sand and the quality of the oil.† The heaviest drills have lately been

*The diamond drill has long been recognized as the most efficient method of recovering a continuous core in rock. All other drills use steel in some form for cutting, but this drill, as its name implies, uses a black diamond, found only in Brazil. The black diamond is pure carbon or is chemically the same as the colorless gem, but differs in crystallization and is tougher for use in industry or drilling. The great advantage of the diamond over steel cutters in core work is that it cuts freely and maintains gauge. To core any distance this is essential as any loss in gauge means loss in clearance, with the consequent choking of the washing fluid, whether mud or water. A steady supply of wash water prevents heating of the cutting tool. The diamonds cut thousands of feet in soft sedimentary formation without appreciable loss in weight. A steel tool quickly loses its edge in rocks that contain grit, such as sandstone or sandy shales. This is the reason why the diamond, although expensive as to initial cost, is generally used in core drilling. Substitutes have been tried but nothing has successfully replaced the diamond. Both double tube and single tube barrels are used with diamond drills. The double tube barrel is designed to have the inner tube suspended on ball bearings and not turn. Water passes down between the tubes, so the core is protected both from washing water and vibration.—J. S. Mitchell of the Sullivan Machinery Co., Chicago, Sept. 13, 1923.

† Clyde S. Longyear, of E. J. Longyear Co., Minneapolis, in *Mining and Metallurgy* for May, 1923.



A DIAMOND CORE DRILL
IN THE DEEPEST FIELD
OF THE UNITED STATES

A Sullivan "FK" machine in the Signal Hill field at Long Beach, Calif. It is here deepening a rotary hole from 3,000 to 5,000 feet for the Shell Co. of California. Its hydraulic cylinder, at the upper right in the view, can lift ordinarily 40 tons under 200 lbs. pressure. This heavy duty drill is nominally rated for 5,000 ft. but may go 7 000 ft. or more.

**CORRECT CORE DRILLING
WILL HELP PLACE THE
PETROLEUM INDUSTRY ON
A MORE ECONOMIC AND
SCIENTIFIC BASIS**

Even if the diamond drill is used only for exploratory purposes and not for production, the accurate rock record makes it possible more intelligently to plan a proper campaign of development. It may prove advisable to get production first from the shallower sands which the ordinary rotary might have missed but which are evidenced by the more or less continuous cores like those shown here—3,400 feet of 2-inch core from Toyah, western Texas.



designed for drilling producing wells of a diameter greater than the mile-deep tests for gold bored in South Africa.

Additional description of this near-ideal core drill accompanies the illustrations herewith.

The advantages of diamond drilling for oil are summed up as follows: By the removal of rock core, accurate records of underground conditions are furnished. It is more rapid than either rotary drilling or standard drilling. The drill operates equally well in soft and in hard strata, and employs mud fluid if necessary. It is adapted to structure testing, ordinary wildcatting, deepening other wells, and production drilling—making the hole of any size, to any depth, within reasonable limits.* Its use in the United States alone may save the investors as much as \$50,-000,000 a year.

Drilling and Operating Oil Wells.† The two types of drills commonly used in the drilling of oil wells are the cable tool and the rotary drill. The nature of the strata in the field in which the drilling is to be done is the determining factor in the selection of the drill.

The **cable tool**, or percussion drill, is generally used in the fields where considerable stone or rock formation is expected to be encountered. This drill consists of a heavy steel stem some 30 feet in length and of varying diameter, according to the size of the hole to be drilled, the stem having a tool known as the "bit" attached to the lower end. To the upper end is fastened a wire cable suspended from the top of a derrick and leading to a hoisting drum, around which the cable is wound. The derrick usually has a 20-foot base, tapering in pyramidal shape to a 4-foot top at a height of 80 feet and may be of wood or steel construction, its strength being conditioned upon the depth to be drilled. A soft formation where caving-in is likely to occur calls for a large hole because it is necessary to insert columns of casing as the depth of the well increases. In the case of very deep wells the diameter is usually large even though caving-in may not be expected.

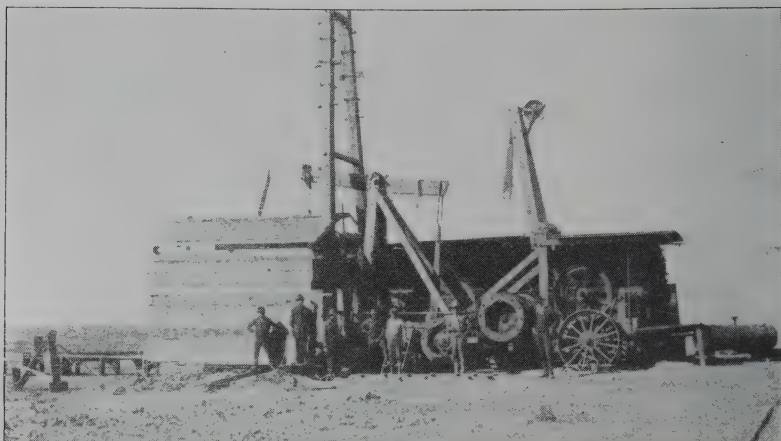
The drum is set in motion by a lever connected with the engine. The lever is controlled by the driller who raises and releases the tool stem, the impact of which forces the tool through the bed of earth and rock. If the drill strikes sand or gravel, a casing is put in to shut off the water, and then drilling is continued through the limestone, clay-shale, or other firm formation. After this formation has been pounded through, a casing about

* *Mining Magazine*, London, October, 1922. Other worthy articles include: A. H. Fay's "The Diamond Drill as an Aid to Oil Prospecting," *Eng. and Mining Jnl.*, Dec. 11, 1920; "Producing Well Drilled with a Diamond Drill," *Tampico Tribune*, Mex., reprinted in the *E. and M. J.*, Jan. 7, 1922; "Diamond Drilling in Oil Production," F. A. Edson, *Oil and Gas Jnl.*, March 10, 1922; "Adapting the D. D. to the Oil Field," F. C. Gill, *The Oil Weekly*, Aug. 26, 1922; and "Drilling Methods in Prospecting for Oil and Gas," *The Petroleum World*, 32, Great St. Helens, London, E. C. 3, Eng., March, 1923.

An inexpensive monograph on diamond drilling for oil, including a directory of drill makers and drilling contractors, which should help small operators to save their funds and find the oil, can be quickly supplied if the demand is great enough. A card to the author will receive prompt attention. In the meantime the instructive catalog of the Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, may satisfy desires for further details.

† From "Wages and Hours of Labor in Petroleum Industry," U. S. Dept. of Labor, James J. Davis, Sec'y; E. J. Henning, Asst. Sec'y. The author has slightly modified and supplemented this popular description which was published as Bulletin 297, April, 1922.—Near the beginning of this chapter reference is made to Captain Lucas, who adapted the rotary principle of the diamond core drill to the diamond-less rotary drill in boring through quicksand and gumbo, where, in the Gulf Coast field, the cable drill had proved useless.

1½ inches less in diameter is put in and continued down with the drilling until oil or another water sand is found or the well is abandoned as a non-producer. The formations penetrated may vary, but at a depth where it is thought there may be oil smaller casing and drills are used than at the beginning. At intervals during the process a bailer or clean-out tool is lowered into the hole to bring up the dirt and rock that have been loosened.



CABLE DRILL—PORTABLE TYPE FOR SHALLOW FIELDS

This is widely used and requires no fixed derrick. Many of the wells, from 1,200 to 1,700 feet deep, in the Sunburst or Kevin-Sunburst field, Toole Co., Mont., have been drilled with portable outfits as shown above. (Photo by the author, Sept., 1923.)

The bailer consists of a long tube having on the lower end a detachable valve and, like the tool stem, connected by a wire cable leading to another hoisting drum. When the drilling is completed and the well "shot" (see 72) the bailing is continued until all the loose dirt and rock have been removed, and the well is then turned over to the production department for pumping.

The cable tool system, in which the bed rock is broken up by pounding or chopping, was used for drilling 91 per cent of the 109,000 oil wells completed during the five years ended with 1918.

The **rotary drill** has come into common use in oil fields where there is little or no stone or rock, because of the speed with which the drilling can be done in soft or caving formations. However, when obstructions in the nature of stone or rock are found in the path of the drill, there is used a specially designed tool, known as a "cone" bit attached to the drill stem.

The rotary drill consists of a rapidly rotating pipe or stem on the lower end of which is attached a fish-tail or a diamond-point bit. To the upper end of the stem is attached a wire cable which suspended from the top of derrick, leads to a hoisting drum. The pipe or stem is rotated at the rate of some 200 revolutions per minute by a horizontal revolving disk through which the stem passes. The rotary disk is driven by chain and sprockets from the line shaft operated by the engine.

Water and thin mud are pumped through the drill stem down into the hole and this forces the material cut away by the bit to rise to the surface. The mud also serves to cement the walls and prevents caving-in of the sides of the hole before the casing can be inserted. The casing is inserted in strings, the number and size depending upon the depth of the well. They are put in at different intervals of depth, seldom exceeding three strings, and ranging in size from 10 inches to 6 inches in wells to a depth of 3,500 feet. After the drilling is completed and the well "shot" the hole is "swabbed in."



ROTARY DRILL, SOUTHERN CALIFORNIA

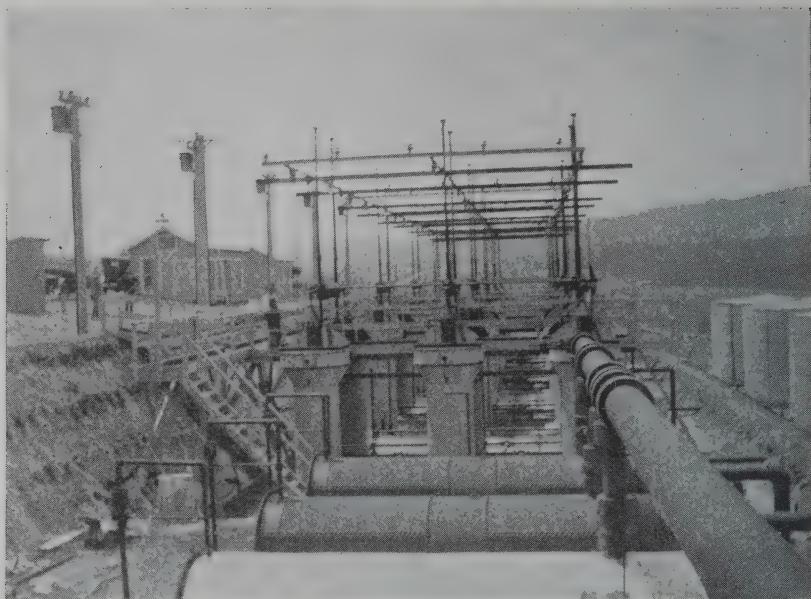
The overdevelopment in 1923 was made possible by the rapid rotary. This view was taken at Santa Fe Springs, Los Angeles County, in August, 1923, and shows the rotary drive sprocket (part of the draw-works), the turntable or gear table (which has a central opening for admitting the drilling tools and drill stems), and several 60-foot sections of jointed drill pipe or stems; also the author and his young friend, Ted Wickersheim.

(Rotary drilling is compared with the cable system in Chapter XVIII, "Business of Oil Production," by Johnson-Huntley-Somers.)

The swab is much like the bailer used in cable-tool drilling, except that between the stem and the valve is a large rubber tube which when compressed and released creates a vacuum. This draws the sand, etc., in to the tube, which is repeatedly lowered into and withdrawn from the hole until the well is "brought in" and ready to be "put on the beam" or turned over to the production department for pumping.*

Pipe-Line Transportation of Crude Petroleum. To most people the tank car is not an unfamiliar sight, and those living on the seacoast may see the tank steamer. Formerly these two containers constituted the principal means by which crude and refined petroleum was transported from one section of the country to another. While both are still in use, the tank car, so far as the transportation of crude petroleum is concerned, has to a great extent been supplanted by the modern pipe-line system though

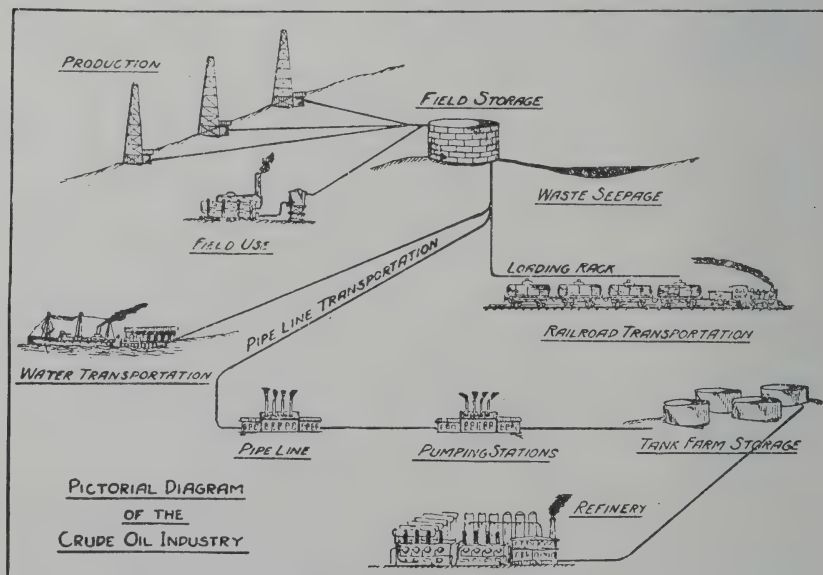
*Because of the risk of running past a pay sand with the rapid rotary, the cable system is customarily substituted when the sand is approached and the well is to be brought in. The costlier rotary method has been blamed in part for the overdevelopment in southern California where the race between competitors calls for rapid drilling. The deepest hole ever drilled with rotary tools is the Brownrig-Keller 2 at Santa Fe Springs, Los Angeles Co. It is being bored by the Standard Oil Co. of California and on October 6, 1923, had reached a depth of 7,212 feet from 7,130 feet on September 17. It was started on September 14, 1922. Deeper wells have been drilled with a diamond core drill in Europe and with cable tools in West Virginia. See end of Chapter II. A record for speed was made by the Shell Co. of California, when Drillers Dunn, Pyles and Sharp ran a rotary down 4,960 feet in 77 days, January 12-March 31, 1923, at Long Beach (Babb No. 2).



—Union Oil Bulletin.

A DEHYDRATION PLANT IN CALIFORNIA

The Cottrell electrical process is used to remove the water from the emulsions of some oil wells before the crude product is moved any distance.



—Bull. 102, U. S. National Museum.

DIAGRAM OF THE CRUDE PETROLEUM INDUSTRY SHOWING ITS
DEPENDENCE ON PIPE-LINE TRANSPORTATION

Note the gathering lines from the wells to the lease or field storage which has smaller units than the tank-farm storage. A common unit of the latter holds 55,000 barrels. Tank farms contain up to 10 million barrels each.

it is still the principal means of transporting the refined product, excepting in the coastwise, the import, and the export trade, where the the tank steamer is the more important carrier.

The nearest thing with which the underground pipe-line systems of transportation are comparable is the water works system of a city; the former being the reverse of the latter in operation, in that its system of arteries gather up the oil from the various wells and sends it to the trunk lines, thence to the refineries, while the water works system sends the water first through the main conduit, later distributing it to the homes of the people.



—Union Oil Bulletin.

PIPE LINE TRANSPORTATION IN CALIFORNIA

Carrying the line over the Rio Hondo near Los Angeles. This shows but one of many engineering problems connected with the oil industry.



SANTA MARGARITA PUMP STATION, UNION OIL CO. OF CALIF.

Few consumers of petroleum products realize how many sources of expense are attached to the crude oil industry alone. In this case the heavy, viscous, oil has to be heated as well as pumped.

To emphasize the size of the modern system of oil transportation, it may be explained that the oil is pumped from the fields of Texas, Oklahoma, and Kansas to refineries along the Atlantic seaboard of the United States and to other refineries located in the Dominion of Canada.

To illustrate these intricate systems of lines, it may be said that one concern has more than 6,000 miles of gathering and trunk lines and nearly 100 main and field pumping stations; while another reports a system of such magnitude that it drains the crude oil from some 10,000 wells and

delivers it to almost any refining center in the United States, save the Pacific coast where there are other systems no less modern than those in the East, the Middle West and Southwest.

These lines are known as "gathering" lines and "trunk" lines, the pipes of the former being of 6 inches diameter or less, while the trunk lines are of 6, 8, 12, and sometimes 16 inches. These very large pipes, however, are confined to short distances because they necessitate more than an ordinary number of pumping stations, which as a rule are found about every 35 miles along the trunk lines, depending upon the hindrance or the assistance offered by gravity.* In California the average interval is about 12 miles because of the viscosity of the oil and the need of heating to make it flow freely. The storage capacity of an 8-inch line is 328 barrels per mile. Its daily capacity under a pressure of 800 pounds per square inch is 21,000 barrels of oil having a gravity of 38 degrees Baumé. To transmit so much in a day the liquid must move 64 miles. About 20,000,000 barrels of oil is generally present in the pipe lines east of the Rockies.

On July 31, 1923, there was stored the enormous quantity of 293,-000,000 barrels of crude oil in the tank farms and pipe lines of the United States. This included also the refinery stocks of imported oil and the California producers' stocks on the leases; and compared with 121,700,000 barrels of crude oil held in similar storage at the close of 1918.

The Refining of Petroleum.† The crude oil having been pumped from the wells and then transported by pipe line, in tank cars, or in tank steamers to the refinery, it remains to be seen how its various component parts are broken up and separated successively one from another to meet the public needs. This is made possible from the fact that the boiling points of the different "fractions" or "cuts" constituting the crude oil are reached at different temperatures. For instance, the naphtha or gasoline in the petroleum begins to boil at a lower temperature than does any other constituent part. It is therefore the first element to vaporize, and at a given temperature the vapor as it passes overhead to the condenser will be composed largely of this fraction, though it will contain also more or less of the heavier oils. The separation of the fractions is aided by the condensing process, since the vapors containing the fractions of higher boiling points are the first to condense.

If the temperature in the still is increased, the kerosene begins to boil, and this is followed in turn, as the temperature rises, by the gas and fuel oils and then the lubricating oil, the last often referred to as the paraffin distillate. The time required to produce the four major fractions varies from 48 to 72 hours.

*Wages and Hours of Labor in Petroleum Industry, Department of Labor, Washington, D. C.

The description of the manufacturing division of the oil industry has also been taken from "Wages and Hours of Labor in the Petroleum Industry," issued by the Department of Labor. The process of refining often begins at the well, because crude oil usually is contaminated with water and may carry in suspension fine particles of sand which must be separated before transporting, unless there is less than 2 per cent of these two. The sand and water are commonly designated as bottom settlings or "B. S." See article on "Petroleum Refining," by C. K. Francis, in *Lefax*, Philadelphia, February, 1922; pages 56-64, "Waverly Handbook," Waverly Oil Works Co., 54th St., Pittsburgh; p. 32, *Oil Trade Journal*, July, 1923, 350 Madison Ave., New York.

† According to Pogue the refining of petroleum is a manufacturing enterprise involving the principles of chemical control and multiple production.

The boiling process usually takes place in an immense horizontal cylindrical "still" mounted over a furnace, the fuel being coal or oil. The latter is very generally used in California because of the scarcity and cost of coal. These stills are of varying capacities, some being as large as 16 feet in diameter and 32 feet in length, or 14 feet in diameter and 42 feet in length, capable of distilling 1,000 to 1,200 barrels at one time; while others are very small in comparison, having a capacity as low as 200 barrels. They are arranged in rows or batteries, a battery frequently consisting of a dozen stills.

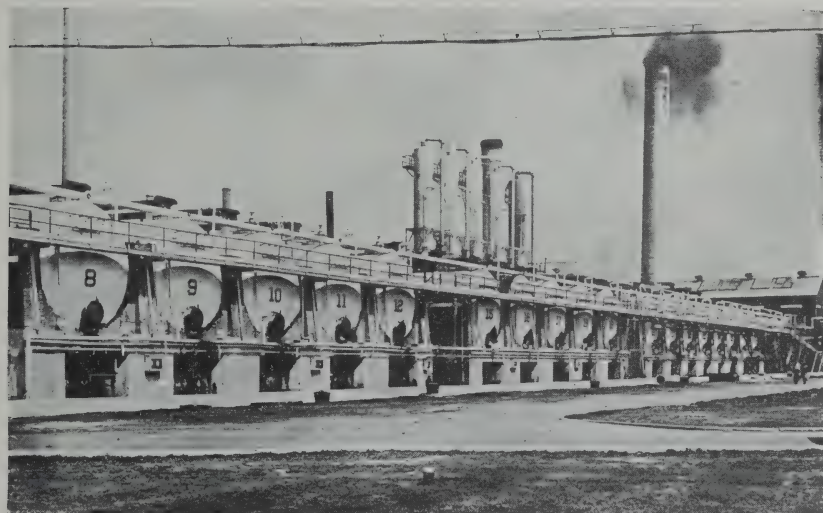


AT LEFT, A PRIMITIVE PETROLEUM STILL IN CALIFORNIA

BELOW, A MODERN REFINERY.

This battery of 20 crude-oil stills has a capacity of 10,000 to 25,000 barrels a day. The Standard Oil Refinery at Bayonne, N. J., can handle 100,000 barrels a day.

—U. S. Geol. Survey.



—Bureau of Mines.

The condensing equipment consists of a coil or system of parallel iron pipes, usually submerged in a large tank of cold water. As the vaporized oil from the still is conveyed through the pipes and comes in contact with the cooling surface it is condensed into a liquid form and is run to the receiving house, the four major fractions being diverted into separate tanks as each is distilled in turn by increased heat. The condensers vary in size with the stills, some of the boxes measuring as much as 20 feet in width, 48 feet in length, and 12 feet in height.

In addition to the cylindrical still there is the "cheesebox" still which is little used nowadays. The "steam still" obtains its name from the fact that the distillation is effected by steam instead of by fire. The "tower still" is so called because of the condensing and separating tower which rises somewhat higher than the still itself. The "continuous still" is one in which the distillation is a continuous process, making it possible to obtain at the same time different fractions from the several stills in the battery. This is done by connecting all the stills of a battery, the temperature being increased at each successive still. The crude oil is charged into the initial still which takes off the naphtha, and flowing from that to the others, each distills its fraction; the residuum is pumped from the last still. The "vacuum still," smaller than the average crude still, is so called because a partial vacuum is created in it by the use of a pump, and this causes some of the fractions to vaporize at temperatures lower than would be the case under atmospheric pressure. "Pressure stills" are those in which the distillation is carried on by subjecting the oil to heat and pressure to increase the recovery of gasoline from the crude.

1. To return to the four major fractions resulting from the distillation of the crude oil, it is found that the naphtha is not of sufficient purity to make it marketable, so it is pumped into a huge tank-like container called an "agitator," in which it is agitated with air or circulated through a centrifugal pump, treated with sulphuric acid and caustic soda, then washed with water, causing the "sludge" or sediment to settle at the bottom so that it may be drawn off. This sludge contains some oil and tar, the former being recovered, the latter being used as fuel. The chemical treatment of the naphtha, not only removes the sulphur and impurities but also improves the odor and color of the product. This process sometimes takes place in a continuous heating plant, so called because the oil and acid are fed continuously through a mixing device. The time required for treating the oil in an agitator of 5,000 barrels' capacity is about 30 hours. Following the chemical treatment the naphtha is subjected to a second distillation in a steam still. Steam is used not only because naphtha boils at such a low temperature that the use of fire is not required but also because the product from the second distillation is believed to be of a better quality if steam is used. (Naphtha is here used synonymously with gasoline.)

2. The kerosene, which was found to be the second fraction obtained from the distillation of the crude oil, is also given a chemical treatment, after which it is redistilled in a combination fire and steam still, the fire causing the necessary heat and the steam preventing "cracking," that is the disintegration of the oil. Even after this process it is sometimes again rerun in a steam still or filtered through clay to further improve its quality.

3. The gas and fuel-oil stock, the third fraction to come over in the distillation of the crude oil, is not usually given further treatment. Gas oil is used principally in the manufacturing of city gas. The varied uses of fuel oil are enumerated in Chapter VI.

4. The lubricating-oil distillate or paraffin distillate, the fourth fraction resulting from the distillation, contain the stock from which both lubricating oils and paraffin wax are obtained. It is pumped from the receiving house to the tanks of the paraffin department, then through the chillers to the presses. The chilling process, which is performed in a

large refrigerating plant, crystallizes the wax in the oil, forming a kind of slush which is then by means of presses filtered through canvas blankets, the oil passing through and dripping into a tank where the "slack wax" adheres to the blankets.

The pressed oil, now wax free, is pumped from the tank to the "reducing stills" where it is reduced to the required viscosity for lubricating oils. This is accomplished by distilling off some of the lighter fractions. The lubricating oil remaining is then pumped to the agitators and there treated with sulphuric acid and caustic soda in order to improve the color and odor and to remove heavy carbon.*

The "slack wax" as it is scraped from the blanket falls into a worm conveyor, which carries it to the melting tank. After melting it is pumped to a settling tank and from there to the paraffin agitators, where it is cleansed with a treatment of sulphuric acid and caustic soda to improve the color. In order to remove the remaining oil, the melted wax is pumped into "sweating pans" and allowed to cool and solidify. The pans are then gradually warmed up, which causes the oil in the crystals of wax to sweat out and flow to the receiving pans, and this oil is then resweated to remove any wax remaining therein. The wax obtained by the "sweating process" is known as "trade scale wax" which may be resweated to refined wax, the latter being filtered through Fuller's earth or animal charcoal to make the product colorless. The filtered refined wax is then run through press molds and made into cakes.†

PETROLEUM PRODUCTS.

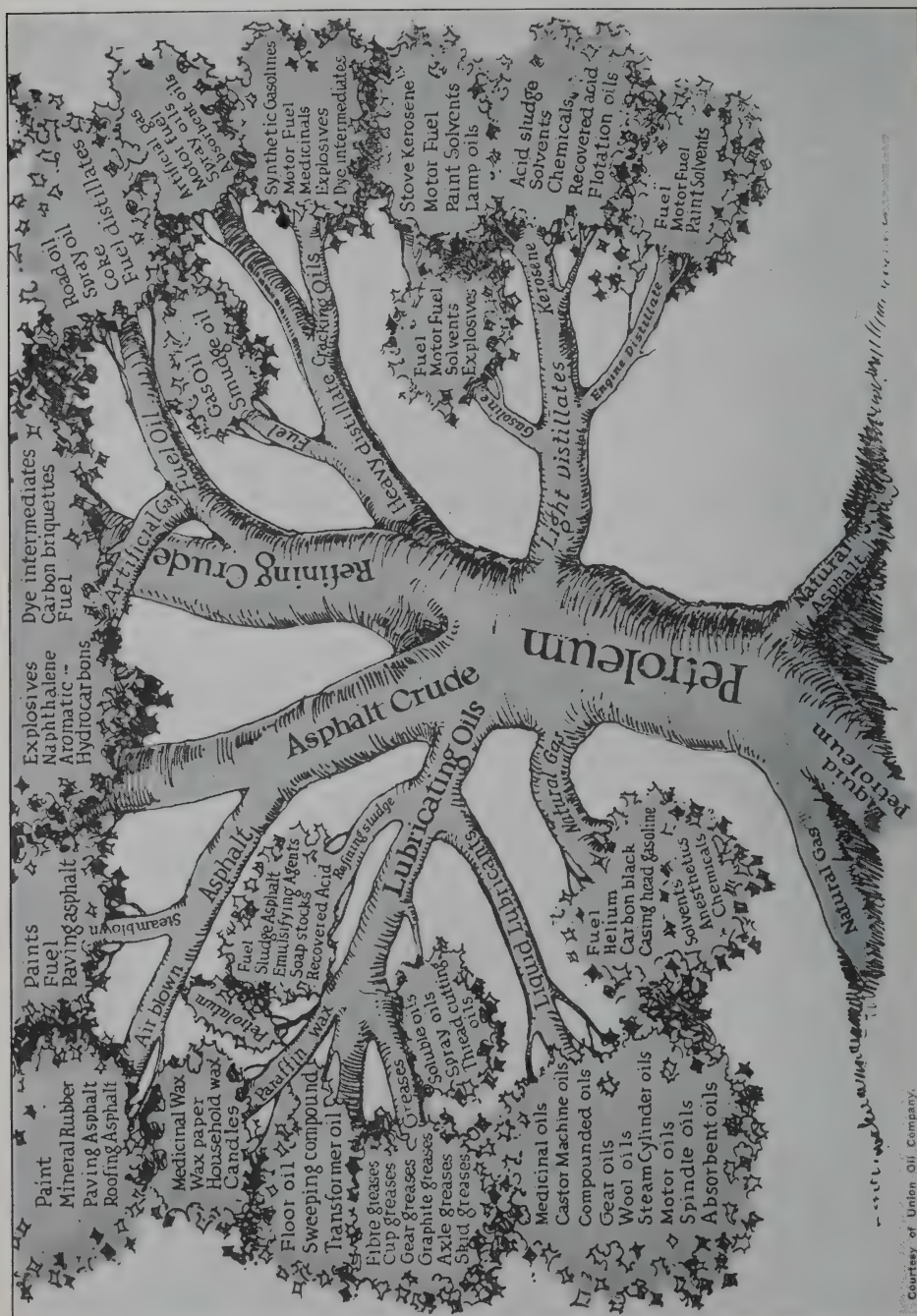
As a result of chemical technology applied to the refining of petroleum, more than 300 distinct products‡ have been obtained. But the possibilities seem almost boundless for increasing this number with the progress of science.¶ In this respect, mineral oil is comparable with coal.

*The "sludge," which is a term used to cover dirt and other impurities, settles in the bottom of the agitator and is then pumped to the acid plant, where it is charged into a kettle of water and blown with steam. This treatment, or cooking, separates the oil, acid, and impurities, the last being known as acid coke. The oil and acid are pumped off and the coke is dumped into a conveyer for transfer to fuel cars.

†The above description applies when paraffin base crude oil is used, and this oil predominates to a greater extent in the Appalachian field than elsewhere in the United States. In addition to this, there is a greater demand in the East for lubricants, the result being that most of the refineries having a paraffin department are located in the East. In the refining of other crude petroleum, however, the method is very much the same, excepting that a less number of finished products are obtained, the residue depending upon the oil that is used. Much of the crude oil produced in Mexico and also in California is of the asphalt base, which yields gasoline, kerosene, fuel oil, and asphalt.

‡About 125 of these are listed in an excellent chart of "Principal Commercial Products of Petroleum—Their Sources and Uses", published by the Standard Oil Co. (N. J.), 26 Broadway, New York. N. E. Loomis, of this company, is the author of a popular booklet, "Refining of Crude Petroleum."

¶Refiners are all familiar with the customary means for either increasing (by polymerization) or decreasing (by cracking) the average size of the hydrocarbon molecules. Cracking processes also tend, to a limited extent, to convert one type of hydrocarbons (e. g. paraffine) into another (e. g. aromatic compounds). If petroleum hydrocarbons are to be raised to a different price level, it is practically necessary to insert a new chemical element into the molecule. Oxygen, sulphur, nitrogen, and chlorine have been seriously considered for this purpose. "Science's Future with Oil", by Arthur D. Little and R. E. Wilson, in *Petroleum Age*, November 15, 1921.



ABOUT 300 PRODUCTS COME FROM CRUDE OIL

For their varied uses see pages 59 and 94

—Courtesy of Union Oil Co. of Calif.

The highest prized by-product of coal is no doubt aniline dye; the most treasured petroleum product today should be the undervalued though limited lubricating oil, so essential for the machinery of industry and yet so tragically burned beneath boilers.

Actually, at present, gasoline is the most generally appreciated product; it must not be forgotten what an important part it played in winning the war by supplying the power for rapid transport by air, sea and land. Further, gasoline from certain oils, as from Borneo, together with synthetic gasolines, contains organic compounds from which the now famous explosive TNT (trinitrotoluene) has been made. Some of our California crudes can be used commercially to produce this death-dealing substance since technical examination has proved their content of suitable aromatic bases.

The future holds forth an astonishing probability of deriving from petroleum a substance much more essential than any gotten out of coal. For years scientists have puzzled their brains to procure edible fats from the mineral kingdom. The close relation between the higher boiling fractions of petroleum and the fatty acids drew their attention in the direction of mineral oils. This relation was very obvious in regard to the burning and lubricating powers of the two. Comparing paraffin with fatty acids 'tis found that the carbon:hydrogen ratio is about the same—a little more than 6:1; but the latter contains 11 per cent of oxygen which is entirely absent from the paraffin. As a result of the diminishing fat supply in Germany during the war her chemists worked frantically on this problem. It is reported that they really succeeded in obtaining fatty acids from paraffin and also in converting these into a carbohydrate food with the help of glycol, a substitute for the related glycerine and itself a petroleum derivative.*

From the moment of announcing that such a super-treasure—substantial food for humans—has emanated from the inorganic empire on a commercial scale, there will be gotten under way stock companies galore. They will proceed to advertise their ability to manufacture food out of atmospheric oxygen plus a little "sweet" petroleum. Investors, then beware!

The consuming public is familiar with only a few products manufactured in quantity out of crude oil, for many of the substances which are known under trade names are not readily recognized as petroleum derivatives. In the following chapter will be indicated the very wide range in the present utilization of petroleum and its products, which furnishes one basis for their classification from the economic standpoint. Commercially there are known: I. The Major Products—1. Gasoline, 2. Kerosene, 3. Fuel (and Gas) Oil, and 4. Lubricating Oil; II. The By-Products—1. Asphalt, 2. Paraffine Wax, 3. Coke, 4. Grease, 5. Petrolatum; besides the many secondary and tertiary derivatives.†

*"Edible Fats from Mineral Oils", by H. T. Stowell in *Lefax*, Philadelphia, July 1921, p. 68.

†See Technical Paper 323, "Specifications for Petroleum Products and Methods for Testing", Bureau of Mines, H. Foster Bain, Director, Washington, 1923, from which the following "Distillation range" for *Motor gasoline* has been taken: When the first drop of liquid is condensed the temperature shall not be above 131°F. When 20 per cent has been received it shall not exceed 221°F.; when 50 per cent, 284°F.; when 90 per cent, 392°F.; and the end point shall not be above 437°F. At least 95 per cent shall be recovered as distillate from the distillation.

From the refinery standpoint the products may be roughly resolved into six great groups, beginning with that having the lowest temperature of vaporization: 1. Liquified Gases, 2. Light Distillates (gasoline, naphtha, benzine, kerosene), 3. Heavy Distillates (light, fuel, stove and Diesel oils—all raw materials for the cracking process to yield synthetic gasoline), 4. Lubricating Oils, 5. (Heavy) Fuel Oils (residual), and 6. Asphalt or Paraffin (residual).

While the products of the different refineries vary in number, nature, grade and utilization, efforts are being made to standardize them, particularly those consumed by our Federal government.† There is, however, a tendency on the part of gasoline producers to lift the end point of distillation so as to get a greater recovery from the crude oil, particularly during the season of maximum demand, by encroaching on the naphtha and kerosene content thereof, these having a higher boiling point than straight gasoline. For motor use in cold weather, this encroachment may be neutralized by the refiner blending such heavy gasoline with as much as 15 per cent of natural gas (casing-head) gasoline. This permits an increased recovery of refinery gasoline amounting to 6 per cent of the original crude or 30 per cent of the usual yield of gasoline, assuming a crude oil that is naturally only one-fifth gasoline.

By the cracking process, the gasoline recovery may be doubled. On the other hand, there is an actual loss of material and a loss because of manufacturing cost; yet the resulting gasoline gives up hardly half the power in the modern automotive engine that the original heavy (fuel) oil would give in the Diesel type of engine.*

In 1910 the average yield of gasoline from crude oil was 11 per cent, while in 1919 this average had risen to about 26 per cent without impairing the quality of the product. This record indicates what efficiency is doing for the oil business, and in time to come still greater results and greater **still** results will develop. The oil technologist is a Progressive and a "cracking" good fellow.†

The figures in the table below may be taken to represent either the **percentage of recovery** or the **actual number of gallons of the primary products gotten out of 100 gallons of the average crude oil** run through all the reporting refineries of the United States during the first quarter of 1923, based on Bureau of Mines data.

Gas and Fuel Oil-----	47	Lubricating Oil-----	4.3
Gasoline -----	30	Wax, Asphalt and Waste-----	9.5
Kerosene -----	9.2		
		Total -----	100.0

**The Mining Congress Journal*, November, 1920, p. 586.

†Editorial in *The Oil and Gas Journal*, Tulsa, Okla., October 29, 1920, p. 3.

CHAPTER V. ECONOMIC ASPECTS OF THE DOMESTIC INDUSTRY.

"All the troubles of the world are economic in nature, and hard work is the only cure for them."—Don Gelasio Caetani, Mining Engineer and Ambassador from Italy, in *Mining and Metallurgy*.

"Had John D. Rockefeller been merely a hoarder and lender of money, the country might yet be paying many times the present prices for lubricants and illuminants, and the 'Oil King' might have been a very common-place business man instead of a financial colossus."—H. L. Barber.

General.

Importance. The economic importance of petroleum has not been overestimated. The interpenetration of agriculture and nearly all other industries by petroleum, the extraordinary significance which oil has for the merchant marine and navies, and the untiring zeal of the research chemist contribute to make of petroleum and its supply an ever enlarging economic question.* The American public has become accustomed to the daily use of products from mineral oil without giving much thought to what the natural substance looks like, where it is produced, why the supply is so limited compared with coal, and how and by whom the prices of the raw and the refined material are determined. Of our population it is said that 60 millions, or more than half of the total, are interested directly or indirectly in petroleum—from the consuming rather than the earning end and yet, how few—certainly less than one per cent of them—are familiar with the most interesting economic facts of either basic or current importance pertaining to mineral oil!

Comparative Magnitude. Allowing 6 barrels to the short ton, the 550 million barrels of crude oil delivered by the 275,000 producing wells in 1922 weighed approximately 90 million tons. This quantity equaled the tonnage of the anthracite or nine-sevenths that of the iron ore mined normally in the United States during recent years. All our agricultural exports for 1921 and 1922 averaged in weight but one-fifth as much. It must be surprising to many that a 3-billion bushel crop of corn and a 12-million-bale cotton crop together make but five-sixths of the mass of the oil output in 1922. George Otis Smith, Director of the Geological Survey, compared the 1918 flow of oil in volume with the summer flow of water in the "Niagara of the South".† He allowed 4½ days' flow to equal the 413 million barrels produced. At this rate 6 days would be required to gauge the yield of petroleum in 1922, and practically 8 days to gauge that of 1923.

Production Per Man. Out of a total of 125,110 (average number) wage earners engaged in the oil and gas industry during 1919, only 93,122 were employed in the production of the crude material. In this respect it was inferior to the anthracite industry of Pennsylvania which required nearly 70 per cent more wage earners. But this really reflects credit on the collective petroleum and natural gas industry since it points to a much higher output per worker, even compared with the entire coal industry, as

*U. S. Commerce Reports, Oct. 24, 1921.

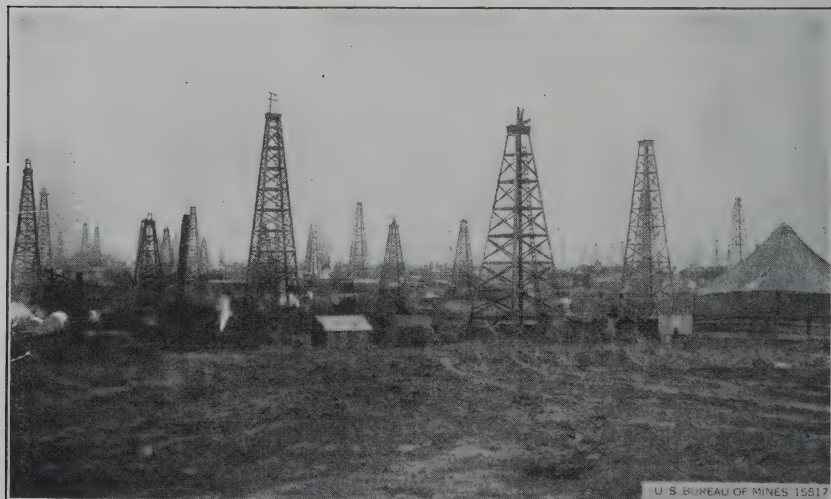
† *National Geographic Magazine*, February, 1920.



OLDEST DRILLED OIL WELL IN THE UNITED STATES
Drake's discovery well—"The Shrine of Petroleum"



COTTON PLANTATION AROUND LULING, NEW TEXAS FIELD



BURKBURNETT OF TOWNSITE FAME, WICHITA CO., TEX.

shown in the following table for the census year 1919 and, unlike the automotive industry, the oil and gas industry deserves praise for not noticeably diverting labor from farm lands into oil fields (and refineries).

Industry	Number of Wage Earners	Total in Millions		Output per W. Earner	
		Quantity	Value	Quantity	Value
OIL AND GAS-----	93,122	378.4 bbls.	\$931.8	4,060 bbls.	\$10,030
ANTHRACITE alone-----	154,571	88.1 s. tons	365.0	570 s. tons	2,360
COAL (Anthr. & Bitum.)--	776,569	554.0 s.tons	1,525.5	713 s. tons	1,965

The values for oil and gas include \$155,900,000 for 961 billion cubic feet of natural gas and \$78,800,000 for 454 million gallons of natural-gas gasoline.

TABLE TO SHOW THE POSITION OF PETROLEUM IN THE MINERAL INDUSTRY, 1922

(Values expressed in millions according to the U. S. Geol. Survey)

Bituminous coal	\$1,294	Nat.-gas gasoline	\$67	Copper	\$127
Anthracite	274	Pig iron	608	Stone	119
Total coal	1,568	Clay products	270	Sand and gravel	61
Petroleum	900	Cement	208	Silver	56
Natural gas	196	Iron ore	158	Lead	52

During the past three or four years the value of crude oil alone has been annually making up 19.5 per cent of the total for all the mineral products; oil, gas and natural-gas gasoline together from 23 to a little over 25 per cent (in 1922).

HISTORY AND GROWTH.

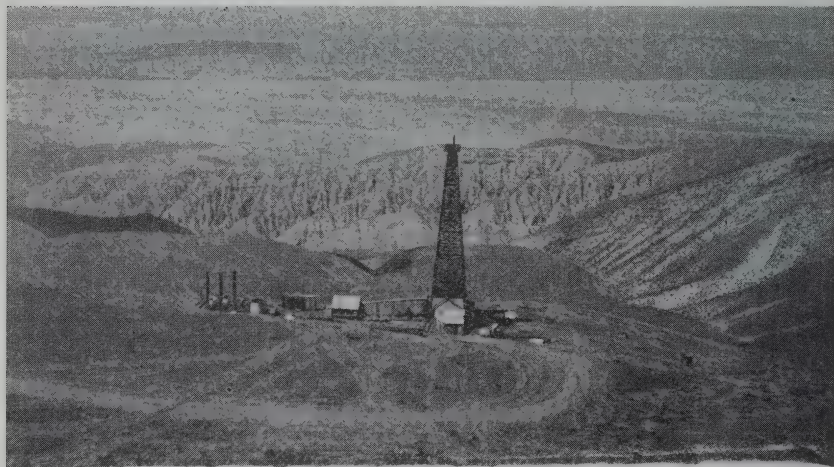
Colonel Drake's Discovery. Despite the fact that these valuable hydrocarbons (oil and gas) had been known to the human race for over twenty-five centuries, it remained for an American, Colonel E. L. Drake,* of the Seneca Oil Company, to become the real founder of the petroleum industry, when, on August 28, 1859, he completed the famous well in Venango County, near Titusville, Pennsylvania. This notable event occurred when "rock oil" was selling for \$25 to \$30 a barrel and soon led to a drilling campaign of wide extent, spreading to Ohio, West Virginia and Canada in 1860. In 1862 the pioneering was carried to Russia where hand digging was done till 1869, when it was supplanted by drilling, resulting in a rise there from 37,400 barrels yield in 1863 to 203,000 barrels in 1869. (See Chapter IX.)

A Nomadic Industry Yet Unlike Gold Mining. Due to the prevailing presence of mineral oil in the less disturbed strata, the drilling of oil wells follows oftener in the wake than in the lead of land development for farming and the establishment of municipalities; whereas the reverse has been true of the mining industry in general, particularly in regard to the gold, silver and copper centers of the western or more mountainous areas of our country. And yet there are places where the oil derricks have

*A magnificent residence in Titusville houses the *Drake Memorial Museum*. This structure was formerly the home of John C. Bryan, D. H. Cady, John D. Archbold and Colonel J. J. Carter, all noted men in the oil industry in their day.

been reared in deserts and in rock lands unsettled or unfit for other purposes and have thus brought pioneers into play. During the last decade the tendency has been for the forests of derricks to spring up almost overnight among the orchards in California, the cornfields in Kan-

On some desolate hill in the desert,
On arid untillable soil,
A derrick appears and the brave pioneers
Start a bit down in search of the oil.
—CHARLES C. WRIGHT.



THE DISCOVERY WELL IN THE WHEELER RIDGE DISTRICT, SOUTHERN CALIFORNIA, 1923.

Completed at 2,130 ft.; initial daily yield, 270 bbls. of 25.5° gravity oil.
—Standard Oil Bulletin, Aug., 1923.

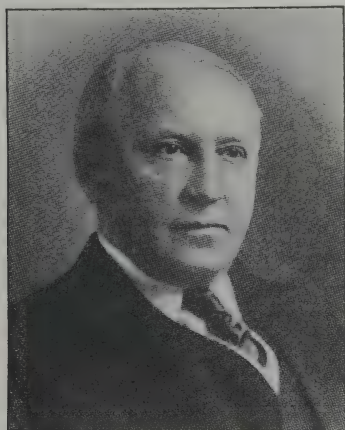
sas, the cotton plantations in Texas, Louisiana and Arkansas, and the house tops of such townsites as Burkburnett and Long Beach.

First Epoch, 1862-1882. This period was characterized by mechanical inventions in the production and transportation of petroleum. Methods for deep drilling were perfected, and the fields of Pennsylvania especially exploited. Transportation through pipe lines and tank cars was introduced, refining methods were extended and improved, and very large gas wells were discovered in drilling for oil. It was near the close of this period, in 1882, that the Standard Oil Trust was formed, and it became the chief agent in promoting a world-wide market for American petroleum and its many refinery products.

The Second Epoch, 1883-1902, marked the rise of the natural gas industry and the bringing of gaseous fuel into domestic use throughout the oil fields. Its use in the manufacturing industry became greatly extended. Thus in 1883 two iron companies piped gas from a well in Butler County, Pennsylvania, to their iron works on the Allegheny River. They found the natural pressure sufficed to force a supply through to their factories enough for their fuel needs in smelting billets and finishing various products. This successful experiment led to a vast extension of pipe lines, and the natural gas industry was born. Capital intelligently guided in the form of a Standard Oil subsidiary sought the advice of Professor I. C. White, who, in June, 1882, had rediscovered the forgotten "Anticlineal

Theory" of earlier geologists. Practically no progress had been made previously in finding oil outside of Pennsylvania, southern New York, southeastern Ohio, and the Volcanic arch of West Virginia, because there was no consistent theory to guide the drill in its search for the hidden treasures of oil and gas. But with the announcement of this structural theory the development of oil and gas spread across West Virginia into Kentucky, and passed from Ohio into Indiana on its westward march.

The Third Twenty-Year Epoch closed with 1922, was distinguished for its large production and utilization of gasoline, accomplished mainly through the invention of the internal combustion engine, and for the general introduction of liquid fuel where available for locomotive, steamship and other industrial purposes. The Diesel engine advanced the efficiency



THE DEAN OF AMERICAN PETROLEUM GEOLOGISTS

State Geologist Israel C. White of West Virginia, who rounded out three-fourths of a century Nov. 1, 1923. He has done much for the conservation of our fuel resources, and the development of the Mexican oil industry by Americans.

He has been a member of the Federal Trade Commission. As an economic geologist and historian he has divided the economic history of the American petroleum industry into three parts.

in the utilization of heavy liquid fuels as compared with their burning beneath boilers. The automobile and the aeroplane are only two of the inventions made practical through gasoline and the combustion engine. Meanwhile the structural theory of oil occurrence has led to a world-wide development of oil fields in many of our States, Latin-America, and numerous lands of the old world.

**TABLE TO SHOW ABSOLUTE GROWTH IN YIELD AND VALUE OF
CRUDE OIL EXPRESSED IN MILLIONS OF BARRELS AND
MILLIONS OF DOLLARS.**

Year	Quantity	Value	Year	Quantity	Value
1860-----	.5	4.8	1912-----	222.9	164.2
1865-----	2.5	16.5	1913-----	248.4	237.1
1870-----	5.3	20.5	1914-----	265.8	214.1
1875-----	8.8	7.4	1915-----	281.1	179.5
1880-----	26.3	24.6	1916-----	300.8	330.9
1885-----	21.9	19.2	1917-----	335.3	522.6
1890-----	45.8	35.4	1918-----	355.9	703.9
1895-----	52.9	57.6	1919-----	378.4	759.9
1900-----	63.6	76.0	1920-----	443.0	1,360.7
1905-----	134.7	34.2	1921-----	472.2	753.3
1910-----	209.6	127.9	1922-----	551.2	900.2
1911-----	220.4	134.0	1923-----	735.0	950.?

Only 2,000 barrels worth \$32,000 were produced in 1859, the first and fractional year of the American petroleum industry. The first year in which crude oil reached and passed the 100 million mark in quantity was 1903, and in value, 1904. It has taken fourteen years (1909-1923) to quadruple the quantity produced in one year; ten years to treble it, and only four years (1919-1923) to double it. In 1922 the yield was almost ten times what it was in 1898, and in 1923 more than ten times what it was in 1901.

COMPARATIVE GROWTH OF THE PETROLEUM INDUSTRY FROM 1913 TO 1923.

	1913	1923	Increase	Per Cent
Population—millions	96.5	110.0	13.5	14
Farm Products, billion dollars.....	10.0	15.0	5.0	50
National Income—billion dollars.....	34.0	50.0	16.0	47
Domestic Exports—billion dollars.....	2.4	3.8	1.4	58
National Wealth—billion dollars.....	188.0	300.	112.	60
Savings Deposits—billion dollars.....	8.4	17.3	8.9	105
National Bank Deposits—billion dollars..	6.0	19.7	13.7	228
PETROLEUM—million barrels.....	248.	735.	500.	200
PETROLEUM—million dollars.....	237.	950.	713.	300

PROBLEMS AND PRELIMINARIES

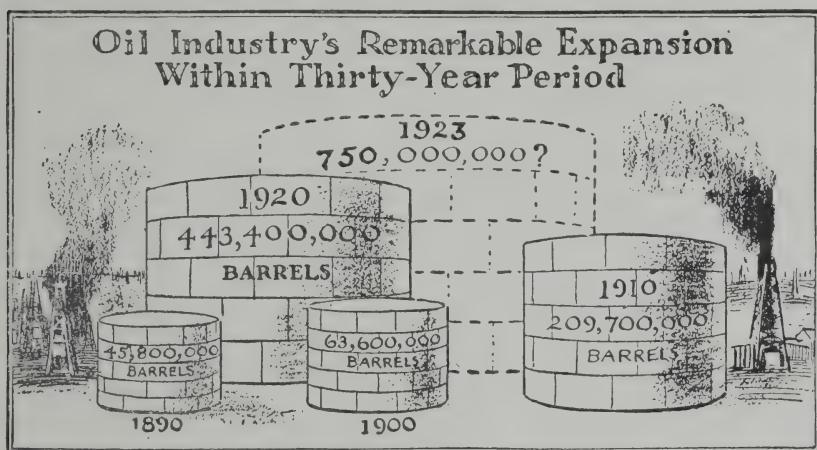
Problems Demanding Early Attention.* In order to aid in the restoration of agricultural prosperity and in the maintenance of American prosperity in general, practical solutions of certain petroleum problems, all more or less economic in nature, cannot be deferred from year to year without disastrous consequences. Sixty millions are in the grandstands impatiently awaiting proper team work on the part of the players. The operators in the oil industry are the players, the two teams are the Standard group and the Independents, and the umpire is Congress holding the cudgel of nationalization to be used if the game is not played fairly and squarely. The questions that perplex us are listed herewith in the order of their evident urgency: (1), prevention of waste after winning both the crude and the refined products; (2), highest possible degree of extraction and utilization of products according to some priority rule that will recognize the lubricating element as the most essential; (3), conservation in the more complete recovery of both oil and gas resources still held in Nature's storehouse; (4), prevention of over-production—a result of intensive or townsite development—by legal restriction like that now tardily enforced in California; (5), stabilization of prices which in part should result from a realization of (4), (6) and (7); (6), standardization of both the facilities and the finished products, fixing seasonal and other permissible ranges in quality; (7), acquisition and development of foreign petroleum reserves.

The public should be vitally interested in these problems. Only 200,000 persons at the most, as investors in exporting companies, are directly concerned in the upkeep of our immense foreign trade in petroleum products. However, the stabilizing influence of a large foreign market on

*See the *Scientific American*, February and August, 1922. Practically every recent issue relates in part to mineral oil.

domestic prices must indirectly affect all of the consuming American public. The questions of multiplying, chemically, the already great number of products, and, commercially, their manifold uses, are of special significance to the refiners and marketers who thereby may obtain increased financial returns from a given quantity of crude.

Since the above was written there appeared in *The Oil and Gas Journal* of October 11, 1923, an article by N. O. Fanning in which he considers six chief problems facing the oil industry: (1) Necessity of controlling crude oil production—to keep it close to current needs; (2), need of locating refineries where profitable to operators; (3), supplying various products proportional to demand; (4), adjusting freights with reference to relationship between land and water transport; (5), perfecting statistics of



output, consumption and movement of crude and refined oils, and (6), defining a national policy for the petroleum industry.

None of these problems can be discussed at length in this limited space; but a few of the more important ones will be dealt with in describing the major economic functions of the oil industry—production, transportation, refining and distribution.

Exploration and Development.* Some practical economics of exploration have already been pointed out, particularly in regard to the employment of geologists and core drills. The proving of reserve deposits without actual productive development must have a strong stabilizing effect both on prices of crude oil and the market value of the securities of the fortunate owners of such reserves. Necessarily, development starts ahead of production, but not before exploration, and rarely continues after any of the oldest wells on a given property or structure have gone dry. The slower the development or the fewer the wells or outlets, the longer the producing life of a pool or any particular property; but the ultimate yield of a limited part of a pool may be lessened if adjacent and competing properties are drilled up more promptly, this due to the elusive nature of

*Based in part on McLaughlin's "Oil Land Development and Valuation", McGraw-Hill Book Co., 370 7th Ave., New York; and *Commerce Monthly*, February, 1922, National Bank of Commerce, New York.

petroleum as a liquid. Where capital is limited, the **rate** of development may prove very slow, particularly if it takes months or even a year to drill one well. Large operators take advantage of high prices by adopting an intensive drilling program so as to market their flush production as fast as facilities permit. This has the added advantage of quicker return of invested capital and gives a greater present worth to a property. Another inducement for prompt development lies in the lowered unit cost of operating many wells by one owner. Depression in the petroleum industry, however, limits to some extent the drilling of wells in known fields, and to an even greater degree the exploration of new territory.

Well Spacing, Drilling Methods and Economic Guidance. A distance of 440 feet between wells, or 4.45 acres per well, seems to be common in many American fields where production is not deeper than 1,000 feet. Such arbitrary spacing may be increased up to 660 feet (10 acres per well) in 3,000 feet territory where the beds are but slightly disturbed. These rules for spacing wells may be useful until bettered by observation.* It is of the utmost economic importance that the most suitable system of drilling be used, core, cable, or rotary, according to the kind of formation and the previous knowledge of the number and depths of oil and water sands.† Victor Ziegler, in "Popular Oil Geology," emphasizes the fact that the economic may be more important than the geologic considerations in deciding whether or not to drill a particular structure. Weighing the economic information may make inadvisable the development of an area otherwise favorable. Those using the nicest of judgment in balancing the two sets of considerations against each other achieve the greatest success in the petroleum industry. The economic facts may be grouped under the following headings: (1) Depth of drilling; (2), possible value of production; (3), accessibility; (4), transportation facilities; (5), operating requirements, and (6) legal status of lands. (For costs of drilling see Chapter XII.)

PRODUCTION OF CRUDE OIL

Production Problems. "The most important problem affecting the producing of petroleum is that of conservation—to obtain a greater percentage of the oil actually contained in the ground than is permissible by the methods most commonly employed."‡ Practiced and proposed methods of increasing recovery are mentioned in Chapter IV and later in this Chapter. Hitherto, applications thereof have been made only in the older fields. The extra expense has not generally encouraged the extension of these conservation methods, particularly when so much of the total production (half of 2.2 million barrels daily during September, 1923) was coming

*These rules are badly broken in the rush of over-development, as in the cases of competitive townsite drilling at Burkburnett and Long Beach. Development is accordingly classified as normal or rational and as uneconomic or competitive.

†According to J. Edgar Pew, V. P., Sun Oil Co., the methods of drilling and operating oil wells have changed but little in 30 years, the chief exception being the application of the rotary process to the softer formations. Probably no other industry needing enormous and ever-increasing investments, would have allowed itself to keep on using original methods and without any marked improvements therein as applied to the operations as a whole. Because they are so numerous and their work so scattered, the average producers have the habit of taking the methods and material handed down whether best suited to their needs or not.

‡U. S. Department of Commerce, Petroleum Division, Henry C. Morris, Chief.

from seven huge fields in or near the flush of their lives. The ratio between flush and settled production varies from year to year, being about 1 to 3 for all the major fields in 1919 and 1 to 4 in 1920, according to R. D. Benson, who estimated that 21 per cent of the entire yield of the United States in the latter year came from wells less than a year old. Local fields having comparatively thin sands and limited areas may reach peak within a year and settled production within 15 to 20 months after the discovery well has been brought in, provided that the wells are not over 3,000 feet deep and development proceeds at a rapid rate, as in the case of Corsicana-Powell. Sometimes the flush period of a newly discovered field or pool culminates quickly; but if the development drags along, a large yield may be maintained for two or three years without the sudden slump to settled or pumping production that characterizes most American pools and wells north of the Rio Grande.

Peak Production and Economic Limit. Sante Fe Springs in the Los Angeles basin is an example of the type of pool where the oil comes from an exceptionally thick "sand" or horizon capable of sustaining an immense output for years if the pool were only entirely exempt from townsite development. Were it not for such over-development in part the peak would not have been pushed up quite so high,—to practically 350,000 barrels daily for a short time in August, 1923, compared with 300,000 for a day or two in April, 1915, in the case of Cushing, Okla. Both took two years to attain the maximum rate. During the last week of September, 1923, the leading California field was still producing at a daily rate close to 310,000 barrels, while Cushing, now fourth in Oklahoma, had a rate of 25,000 barrels and was very slowly declining. The proven area of Santa Fe Springs is not much less than 2.5 square miles, say 1300 acres, while that of the Cushing field, including its Droppedright, Drumright and other subdivisions, must be at least 10 if not 20 times as large. However, it is doubtful if Santa Fe Springs, no matter how large the area from which the oil drains into its small structure, will be able to produce 25,000 barrels daily 11 to 12 years after its discovery. At any rate, because of the greater cost of pumping, after these wells cease flowing, the economic limit per well looms high.

Chiefly due to the temporary depression in the oil industry, the Kevin-Sunburst field found early in 1922 near Shelby, Montana, and representing a production type quite different from the two described, is enjoying a moderate rate of development and a slow approach to peak. Its development and future production may be designated as extensive and not intensive. Because of its unsurpassed area for a single structure it is bound to have a long life although its yield per acre may be relatively low. Fortunately for economic development it has fallen into the hands of operators who have large holdings and can prevent over-drilling and over-production and procure a high percentage of recovery. Although the gravity of the Kevin-Sunburst oil is not quite so good as that of the Cushing field, and although the sands are only four-fifths to one-tenth as thick as the four productive sands of the latter, the economic limit of production per well will no doubt prove less than the seemingly low limit allowed for pumping wells in Cushing and most of the other pools or districts within

the Mid-Continent field, namely 75 barrels per year.* There are several reasons for this favorable economic situation of the Kevin-Sunburst field: (1) Smaller cost of lifting the oil to the surface due mainly to the shallower depth, hardly two-thirds of the 2500 to 2700 feet depth of the Bartlesville or principal sand in the Cushing field; (2) less return of capital through depletion and depreciation since land, leases, and drilling are not so expensive; (3) smaller costs for operating, other than pumping, particularly because a railroad already taps this territory; and (4) nearness to markets removed from competing sources of supply. This last advantage is more pronounced with reference to Wyoming fields than to Cat Creek, the only other Montana field of present importance. For instance, the Canadian markets in the wheat fields to the north are about 500 miles nearer Sunburst than Salt Creek (in Wyoming).

Production Per Acre. Roughly estimated, the ultimate yield per acre of producing oil land averages 3,400 barrels, assuming 300,000 wells will eventually have discharged 7.1 billion barrels of oil from 2.1 million acres on the basis of 7 acres to the well. In this calculation the past production of 200,000 exhausted wells from 2 million acres has been disregarded; their ultimate yield was likely not less than what the future yield of the 300,000 live wells alone will be after January 1, 1924. For comparison with this approximation of 3,400 barrels per acre—average **ultimate** yield for all the major fields of the United States—there are given below specific figures to show the acre output for selected areas.

PAST YIELD PER ACRE, GULF COAST DOMES TO JANUARY 1, 1921†

Dome or Field	Acreage	Bbbs./Acre	Dome or Field	Acreage	Bbbs./Acre
Jennings (La.)-----	142	223,395	Batson (Tex.)-----	477	63,636
Spindletop (Tex.)-----	265	177,606	Saratoga (Tex.)-----	450	45,641
West Columbia‡-----	140	134,904	Humble -----	2,225	38,062
Sour Lake-----	450	130,869	Hull -----	974	6,545
Vinton (La.)-----	140	111,301	Damon Mound-----	358	6,185
Edgerly (La.)-----	76	77,194			
			Average -----	5,697	56,400

PAST YIELD PER ACRE OF OTHER AREAS TO JANUARY 1, 1921.

Caddo (La.) (1 property)-----	44,800	Cushing (Okla.)-----	11,000
Kern River (Cal.) 6,932 a.-----	32,300	Glenn Pool (Okla.)-----	7,500
Healdton (Okla.) (1 property)--	29,450	Bartlesville (Okla.)-----	1,800

Operators in the high-grade Tonkawa filed in Kay and Nobles counties, Oklahoma, believe that the South pool thereof will ultimately yield 30,000 to 35,000 barrels per acre. Col. A. E. Humphreys, of Mexia and Powell fame, quotes F. Julius Fohs as authority for an estimate of 600 million barrels total future production of the Los Angeles basin. Includ-

*Part of this data derived from "The Sunburst Oil Field of Montana", a paper prepared by Dorsey Hager for the American Inst. of Min. and Met. Engineers, and reprinted in *The Oil and Gas Journal*, March 1, 1923.

† *The Oil Weekly*, January 21, 1922. Weighted average computed by the author.

‡ The Japhet lease of 20 acres operated by The Texas Co., had produced to the early part of 1923 about 12 million barrels in 5 years, or 600,000 barrels to the acre, and is still good for 4,000 barrels a day.

ing the output to the end of 1923, and assuming that 15,000 acres—one-eighth of the state's total—covers the proven territory in Los Angeles and Orange counties, the writer roughly gets 60,000 barrels per acre as the ultimate average yield of the Los Angeles basin.*

Production Per Well. Knowledge of the usual or expected yield per normal well is of more practical value than that of the average yield of a field that is spotted, spectacular, or otherwise irregular in the spacing and performances of its wells. (See Chapter XI.) The law of averages works better after a pool or property has passed its days of flush production. This law helps valuation engineers to prepare decline curves and future production curves so that the value of undrilled but proven oil land may be ascertained within reasonable limits.† Information as to the initial yield of a single well, particularly the discovery well that proves 160 acres centered about it, is of little value. The flow may be at an extra high rate because of the great original gas pressure, compared with the corresponding flow of later drilled wells; and this rate, stated for the first 24 hours, may be based upon the actual yield during the first 2 or 3 hours only where the measuring unit is limited. Interested speculators and stock promoters advertise promptly and widely a well's initial flow and refrain from publishing its daily record at the end of 30 days when the flow has become more or less settled and generally less than one-fourth of the initial. Appraising engineers prefer a monthly record extending over half a year at least, if the value of a property must be based upon the performance of a single well. Rarely does the rate of yield rise after the first 24 hours. Exceptions include: (1) The largest well known in the Cushing pool to the end of 1915, which increased from 10,752 barrels the first day to 10,848 the second day and settled to 4,000 within a week; and (2) a number of wells at Signal Hill or Long Beach, which in 1922 increased their flow after freeing themselves of sand.

During September, 1923, the average daily yield of nearly 300,000 wells in the United States approximated 2,250,000 barrels or 7.5 barrels per well. The Census Bureau reported 37,400 wells producing oil or gas on December 31, 1889. In that year they yielded a little over 35 million barrels of petroleum or at the rate of 2.6 barrels daily, disregarding the

* In arriving at this result, due consideration has been given to Joseph Jensen's paper read before the Los Angeles convention of the American Association of Petroleum Geologists in September, 1923. Estimates therein were made of the yield in 1924 not only for Santa Fe Springs, Long Beach, Huntington Beach and several older fields, but also for Torrance-Redondo and the latest discovered field at Compton. Assuming the producing area of all California fields to be 60,000 acres (in addition to 55,000 acres proven but undeveloped), and the total yield 1,800 million barrels to the end of 1923, the average output per acre becomes 30,000 barrels to date. Thickness of sands, their number, porosity, degree of saturation, pressure of the gas, and viscosity of the oil, are the chief factors affecting the ordinary recovery per acre.

† See page 73, revised "Manual for the Oil and Gas Industry," by Fay, Reinholdt, etc. Note particularly the Law of Equal Expectations advanced in 1918. The original edition of this Manual contains data of 11 years' yield from 6 wells on an Oklahoma property from which the author has computed the yield per well per day. The resulting averages lend themselves to the construction of a typical decline curve, as follows, beginning with 1906 and ending with 1916: 25.6, 14.5, 6.9, 5.05, 3.22, 2.06, 1.12, 0.75, 0.49, 0.26, and 0.10. The original "Manual" was prepared by Ralph Arnold, James L. Darnell, and others.

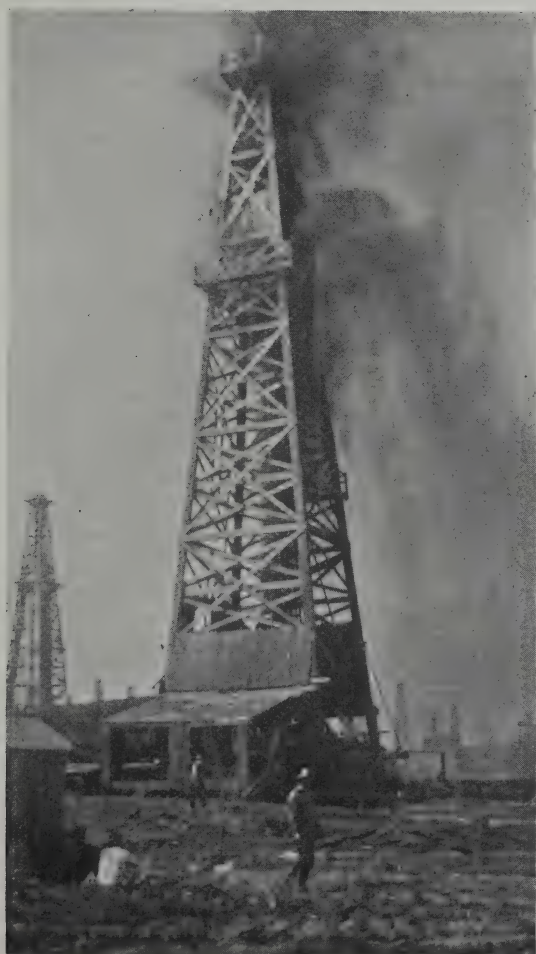
number of gas wells included. On this basis of 750 million barrels output in 1923 the daily average per well approximates 7 barrels, an increase of 4.4 barrels in a third of a century. Calculated from Census data, the daily average was 2.8 barrels in 1909, 4 barrels in the 5-year period of 1910-1914, and 4.5 barrels in that of 1915-1919. The steady gain has been more marked during the past four years in the daily output per well than in the number of producing wells: 1920, 4.7 barrels from 258,600 oil wells; 1921, 4.9 barrels from 274,500; 1922, 5.3 barrels from 285,000; and in 1923, 7 barrels from 300,000 oil wells.

Causes of Increase in Average Yield. Ordinarily the daily yield per acre or per well would drop off from month to month and year to year, as it has been doing in the older fields east of the Mississippi excepting in the few where artificial means* supplement the failing gas pressure that usually drives the oil through the porous rocks and into the pumping wells. Thus, in a certain part of the Illinois field, where no such process is used, the production per well fell from 3.22 barrels in 1911 to 0.99 barrels in 1920. Artificial methods, such as vacuum, compressed-air, and water-drive, not to mention the mining of sands, could show a gain for the whole country if universally applied. But there is no economic incentive for such conservation as long as new fields, overlooked pools, and deeper sands are discovered at frequent intervals. The finding of these and their development are then the causes not only of the increased average daily or yearly yield per well but also of the great gain in aggregate production which is now enough to overflow our domestic markets. These two results are distinct inasmuch as it would be possible to have the same relative growth in the number of producing wells and in the total production without any concurrent increase in the yield per well.

Overproduction of 1923 from Deep Wells. Practically all of the oil now coming from the three leading California fields—at a rate of more than 650,000 barrels daily during September, 1923,—has to rise from 4,000 to 6,000 feet to reach the surface; and that from the flush (Cor-sicana-)Powell field in Navarro County, Texas,—at a rate of 170,000 barrels—starts from a level nearly 3,000 feet deep. In other words, 36 per cent—more than one-third—of the petroleum being produced in the United States during the fall of 1923 was coming from an average depth not far from 4,000 feet. These four fields, now among the first 6 or 7 in rank of current production rate, account for all the 700,000 to 750,000 barrels increase in the course of a year since September, 1922, in which month the daily rate averaged 1,540,000 barrels. No other natural resource developed on a large scale has ever shown such a gigantic gain, almost 50 per cent, in so short a time. This is all the more sensational since the record output was not reached in response to any sudden and inordinate demand for more petroleum.

Tragic Consequences. A number of economic tragedies have resulted from this phenomenal and unexpected flood of mineral fuel: (1) Loss of crude oil through lack of gusher control and suitable storage; (2) upset

*In the Allegheny and Bradford fields, Pa., 18,000 wells attached to one pipe line showed 23.8 per cent increase in 8 years due to the so-called "water-drive" by which water pressure is put on the rocks. A shot of nitro-glycerine has also been known to rejuvenate an individual well.



OVERPRODUCTION IN
1923 HAS COME FROM
DEEP WELLS,
PARTICULARLY IN
SOUTHERN CALIFORNIA

Above appear two views of Signal Hill at Long Beach, one taken before and the other after development began. This overdeveloped field was discovered June 25, 1921, by the Shell Co. of Calif. Despite their large holdings there was, in August, 1923, only 2 acres to 1 producer on the average. About the middle of November, 1923, the 272 wells were yielding about 240,000 bbls. daily. Estimated yield in 30 months ending with Dec. 31, 1923, 86,000,000 bbls. Deepest well, 5,972 ft.

At left is seen the Shell Co.'s Andrews No. 3 well. It came in at 5,050 ft., being the first producer below the 5,000-foot level. This compares with the average depth of 2,800 ft. for all the U. S. domestic yield in 1921-22.

in markets with the general bad effect of uncertain prices and the worse indirect effect of abnormally low prices for motor fuel upon the output of motor cars with all their attendant tragedies; (3) waste in use of products because of cheapened gasoline in particular; (4) overbuilding of storage and pipe-line facilities at great expense which the ultimate consumer must eventually stand; (5) financial failure of many small producers either from inability to store their crude product or from necessity to sell it at a loss; (6) elimination or reduction of profits, in turn cutting off, or down, the customary dividends to numerous stockholders of whom some may have no other source of income; and (7) consequent depression in the market value of securities of crude oil producers. To illustrate the last stated effect, the shares in 10 leading companies declined from the year's high early in 1923 at an average rate of over 56 per cent to what they were quoted at late in September, that is, during a period of about six months. With reference to (5) and (6) the losses to some producers in 1923 must have been immense in their aggregate—much more than the net loss of nearly \$60,000,000 on 551.2 million barrels crude marketed in 1922 for \$775,000,000.

CHAP. VI. ECONOMIC ASPECTS—Continued.

A Demoralized Market and Past Price Fluctuations. The predicting of crude oil prices is as great a guess work as the forecasting of future production and the estimating of recoverable reserves for the entire country. Past price records are worthless in forecasting petroleum prices for short periods of one-half to three years in view of the fact that nobody knows just when and to what extent a sudden slump or a precipitous rise may occur in production, respectively through a simultaneous stoppage or slackening in nation-wide new development or through contemporaneous discoveries and stampedes of drilling in new fields or deep sands. Despite the present demoralized market, better prices are bound to come, certainly within a year, since the majority of producers cannot and will not carry on much longer at a loss*. The only oil well operators who are profiting during the temporary stage of over-production are the few lucky lessees in the new fields of California, Texas and Oklahoma. **Price control is apparently not in the hands of the older or more permanent producers.** As a matter of fact, in their most important current aspects the oil industry and the oil markets are dominated not so much by current events as by estimates or conjectures of what is ahead, either probable or possible.†

Price changes in crude petroleum during the past ten years prove that the industry has not been coordinated and that fluctuations do not closely follow the prevailing trend in prices of necessities. Just after the outbreak of the War, crude oil quotations fell off while prices in general were boosted because of the menace to merchandising; and again, throughout 1920, prices for crude oil were maintained at the level of the latter half of 1919, while prices for most commodities continued to drop. In spite of many downward reactions, the price trended sharply upwards at an average rate of 22 per cent annually during the eight-year period, 1913-1920. Pogue claims this upward tendency is mainly due to (1), the increasing cost to drill arising from the great number of well-feet per barrel; (2) the increased cost of labor and material, and (3), the mounting demand for oil products.‡ However, except in fields nearing exhaustion and in so far as the high-cost areas set the price pace for the entire country, **the cost of production does not dominantly influence the price of crude petroleum**, which has to carry in addition the intangible but very appreciable item of (4), incentive for exploration. With steady progress toward

*Out of more than 285,000 oil wells in the United States some 260,000 are being operated at a loss, declared W. H. Gray before the American Oil Men's Association at their Chicago meeting, October 2, 1923.—The Oil Weekly, October 6.

†Standard Daily Trade Service, January 27, 1923. Gilbert and Pogue, in Bulletin 102 of the U. S. National Museum, p. 13, state that the price of crude petroleum (at any one time) varies considerably according to quality, distance from market, and other factors. The paraffin oils of light gravity, such as those produced in Pennsylvania, are the most valuable because they yield the largest percentage of products in demand, while the asphaltic oils of heavy gravity, such as those from parts of California and the Gulf region, bring a price roughly a fourth of what the best quality oil commands.

‡Page 241, "Economics of Petroleum," published by John Wiley & Sons, Inc., 1921.

depletion of the resource, the increasing proportion of drilling needed to sustain output may be expected to make the cost of production rise and weigh more and more in the price outcome.*

PRODUCTION AND WEIGHTED AVERAGE ANNUAL PRICE OF CRUDE OIL AT THE WELL

At 5-year intervals since 1875			During the 11 years, 1912-1922		
Years	Million		Years	Million	
	Bbls.	Dollars		Bbls.	Dollars
1859-1875 -----	74.1	2.92	1912 -----	222.9	0.74
1876 -----	9.1	2.52	1913 -----	248.4	0.95
1880 -----	26.3	0.93	1914 -----	265.8	0.81
1885 -----	21.9	0.94	1915 -----	281.1	0.64
1890 -----	45.8	0.77	1916 -----	300.8	1.10
1895 -----	52.9	1.09	1917 -----	335.3	1.56
1900 -----	63.6	1.19	1918 -----	355.9	1.98
1905 -----	134.7	0.62	1919 -----	378.4	2.01
1910 -----	209.6	0.61	1920 -----	442.9	3.07
1915 -----	281.1	0.64	1921 -----	472.2	1.72
1920 -----	442.9	3.07	1922 -----	551.2	1.66

Variations in specific prices for particular grades have been greater than in average prices. Thus, because a market had to be made, Pennsylvanian crude depreciated from \$20, the earliest price on record, which persisted from September, 1859, to January, 1860, to \$2 in December, 1860, and to 10 cents during December-January, 1861-1862, averaging but 49 cents for the year 1861. This grade reached another peak in 1864, \$14.00 during July, the average for that year being \$8.06. Extreme lows in Pennsylvania prices were recorded as follows since 1862: 49¼ cents in July, 1882; 51¼ cents in June, 1884; 50 cents in August, 1891, and 50 cents in October, 1892. The lowest average annual price of this high grade petroleum reached since 1862, when it was 49 cents, belongs to a year of very dull times, 1892, when it was 55.6 cents. Between January, 1869, when the specific price was \$7 per barrel, and March to December, 1920, when it was \$6.10, Pennsylvania crude sold at \$4 or more only in these other years: 1870, 1871, 1872, 1876, 1918 and 1919. According to the U. S. Geological Survey's report, "Petroleum in 1918," by E. R. Lloyd, the average price per barrel for the 1,221.8 million barrels of Pennsylvania crude produced in the entire Appalachian field from 1859 to 1918, inclusive, approximated \$1.43. The corresponding figure for the 787.4 million barrels of similar grade produced in Pennsylvania alone during the same period was about \$1.45.

Other fields have experienced exceptionally low prices for crude oil. The average yearly price of petroleum marketed in the Lima, Ohio-Indiana field during 1888 and again in 1889 was only 15 cents. These were the third and fourth years of its productivity, and then for the first time this field furnished more than one-third of the total yield of crude oil from the whole United States. In the Gulf field, during 1901, the year of the Beaumont or Spindle Top discovery, its 3.6 million barrels of heavy

* The result will be complicated by the advancing use of engineering methods in the place of unorganized wildcatting, by a more scientific analysis of depletion data, and by the growing strength of the demands for petroleum products, all of which tend to stimulate increased prices for the crude.—M. L. Requa, General Director of the Oil Division, U. S. Fuel Administration.

crude (not yet in demand for fueling) brought an average price of but 17½ cents per barrel, although this quantity made no more than 5.2 per cent of the nation's output. The great gushers of the Midway-Sunset field in California prior to 1915 yielded so much oil that prices there slumped to the low level of 20 cents and storage was over-loaded. As a result of the war and the rapid strides of the automotive industry, the great surplus was wiped out.* Prices rose throughout the State and stimulated the search for new fields. The average price in California was 42.2 cents in 1915; 59 cents in 1916; 91.8 cents in 1917 (the year of the Montebello discovery), and \$1.218 in 1918, the first year that "dollar oil" had appeared in the State since 1894.

PRICE CHANGES IN PENNSYLVANIA CRUDE OIL DURING 3 MONTHS TO OCTOBER, 1923

Date	Price	Increase	Date	Price	Increase	Date	Price	Decrease
Dec. 30, '22	—	\$3.00	Feb. 1	—	\$3.80 .10	May 6	—	\$3.75 .25
Jan. 1, '23	—	3.25 .25	Feb. 3	—	3.90 .10	May 14	—	3.50 .25
Jan. 16	—	3.35 .10	Feb. 8	—	4.00 .10	June 18	—	3.25 .25
Jan. 18	—	3.45 .10	Feb. 15	—	4.25 .25	July 9	—	3.00 .25
Jan. 29	—	3.55 .10	April 11	—	4.00 .25†	Sept. 20	—	2.75 .25

Premiums and Posting of Prices. The bulk of the crude oil produced in this country is purchased at open-market prices that are announced or "posted" by big marketing companies or purchasing departments connected with the big refiners. Most of the oil is taken from the producers' field tanks by pipe lines that are owned by or affiliated with the big refining companies and pumped through the lines from the fields to the refineries or to storage tanks of the purchaser.

The posted price is the price at which one or more of the principal purchasers in a given field offer to buy crude petroleum at the producer's tank. Some of the crude petroleum is bought direct by small refiners, who often pay a premium over the posted price. The producer, in selling to the large purchasers who offer to buy at their posted prices, has the advantage of an assured sale at any time, irrespective of quantity. Hence, the small refiner must offer the producer an extra inducement in order to secure the small quantities his refinery can usually take.

When the small refiner pays a large premium it is usually for a particularly desirable quality of crude; or because, in times of declining production he is not able to secure sufficient quantities otherwise. On the other hand, in times of flush production small refiners have often been able to buy their oil at less than posted prices. When the large purchasers find that the proportion of oil sold at premium prices is so great that they have difficulty in securing oil to meet their own requirements, they advance their posted prices.

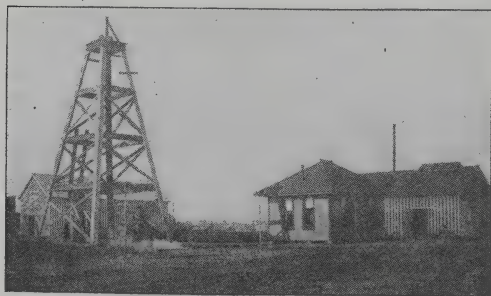
*Eric A. Starke, formerly geologist with the Standard Oil Co. of Calif., quoted in the *Wall Street Journal*, April 27, 1923. See "Stocks, Storage and Stabilization" following. Prices and stocks generally move in opposite directions. For view of Spindle Top see page 36.

†Decrease. Altogether 7 cuts, aggregating \$1.65, were made up to Nov. 13, the date of a 15-cent cut.—*Boston News Bureau*. The geographic range of prices during 1923 is given in Chapter VIII. All prices of crude are at the well. Prices in most fields east of the Rockies rose late in December. Since the low of \$2.60 for Penn. crude was established Nov. 13, its price rose \$.25 Dec. 14, \$.25 Dec. 26, \$.15 Dec. 31; \$.15 Jan. 7, 1924, and \$.10 Jan. 10.

The glut of oil from the Cushing pool proved calamitous to premiums for light oil of the Mid-Continent field. The posted price in 1915 sank to 40 cents per barrel, though large quantities also sold as low as 25 cents. At other times premiums have gone to unprecedented levels, and in the Ranger Field, where the production fell off sharply in 1920, they ran as high as 50 cents per barrel. In the Garber pool, Oklahoma, the scarcity of high-grade refining crudes resulted once in the payment of premiums as high as \$1.75 per barrel.*

Causes and Cures for Overproduction. Domestic production seemed to satisfy demands quite fully up to 1916. Beginning with that year a gap occurred and gradually widened so that in 1920, notwithstanding the great gain of 65 million barrels over the yield the year before, the shortage amounted to 87.5 million barrels of crude oil. In 1921 the shortage was practically 54 million barrels and in 1922 only 35 millions. In the meantime, Mexico had been more than filling the gap so that a reduction of 23.5 million barrels in stocks during 1916 was changed to a surplus of over 62.5 barrels at the end of 1921. Exports of crude petroleum have never proven to be an important factor; they increased from hardly 5 million barrels in 1918 to little more than 10 millions in 1922, the average from 1913 to 1917, inclusive, being but 4 millions.

Sensational reports of the salt water invasion of the southern or light-oil district in Mexico, circulated early in 1921, certainly stimulated wildcatting in the United States. As a matter of fact, Mexican shipments to our country have been maintained at a remarkable rate despite a partial realization of the pessimistic forecasts. (See Chapter IX.) As a result of



—The Oil Weekly.

A CONTRIBUTOR TO OVER-PRODUCTION

The deep Powell pool (Woodbine sand) in the old Corsicana field was not found before January, 1923, and since has furnished a great sensation, in October, putting Texas next to California. This view shows a shallow well of the original Powell pool (650 to 950 ft.) opened in 1900; the deep development is pictured in Part Two.

the wide-spread wildcatting, a number of new fields have been found north of the Rio Grande, one of them even close to the Canadian line, namely the huge Kevin-Sunburst field in Montana. Fear of a failing supply from Mexico can scarcely be blamed for the great discoveries and the resultant enormous over-production that have occurred in California. It is this overabundance of high gasoline oil in a State which hitherto had been economically extraneous—as far as it affected the region east of the Rockies—that has sort of dynamited the markets of the east and the middle west. Great

*Pages 3 and 32, Report of the Federal Trade Commission on "The Advance in Price of Petroleum Products," published in 1920 as House Document No. 801, 66th Congress, 2nd Session.

as the gain has also been experienced east of the Rockies, the American market could easily have absorbed it all because of the abnormal, even outrageous, advance in the output of automobiles and because of the tendency to substitute fuel oil and kerosene for coal wherever feasible.

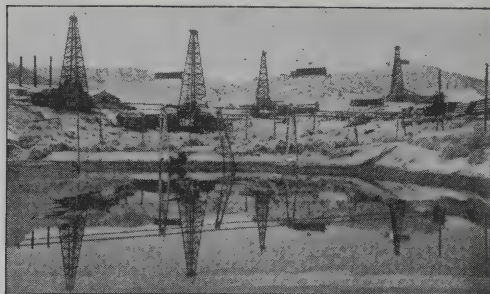
Four causes for the excessive yield in California have been stated by Ralph Arnold.* (1) The false assumption that initial production can be counted on as the average for the life of the field, deluding many into drilling where fewer wells and slower development would prove the proper and (more) profitable solution; (2), rapid development through the use of rotary drills at twice the cost of cable drilling; (3) small holdings which have induced intensive drilling, and (4), stringent lease requirement for offset drilling. President Thos. A. O'Donnell, of the A. P. I., speaking at the St. Louis meeting in December, 1922, referred to two reasons for the scandalous over-production in California: (1) When oil was at a good price extreme competition between the active companies of the State for leases which brought about heavy drilling operations as well as extravagant bonuses and royalties, and (2), following that there has been a development of the well-known promoter type.

Various remedies have been proposed to rectify the resultant depressed situation which has prevailed throughout the entire petroleum industry with the exception of the tanker trade and the business of building pipe lines, storage and refining facilities. The State of California has made more rigorous the requirements of small and speculative operators to have a large bank deposit before being granted a permit to drill. Some Burbank (Okla.) operators agreed, as long ago as late in April, 1923, to stop new wells near the top of the sand and not drill them into production until pipe line facilities had been improved. Additional storage as well as needed pipe lines have been provided. The drilling of new wells has been suspended here and there, and old wells, particularly those farthest from tidewater, have been pinched down or shut in completely so that one time in the late summer of 1923 it was estimated that the potential production exceeded the actual output almost half a million barrels per day. Pipe line companies have compelled curtailment on the part of producers by prorating the pipe runs. These various remedial measures of an economic nature must not be confused with conditions which are subject to technologic control and which retard capacity production such as improper shooting of wells, water not shut off, improper cleaning with packed sands



PRES. THOMAS O'DONNELL
of the Am. Petroleum Institute, 1923
—The Oil Weekly.

*Address quoted in *Mining and Oil Bulletin*, August, 1922, published by the Californian Chamber of Mines and Oil, Geo. M. Swindell, Secretary.



EARTHEN STORAGE OF VERY HEAVY OIL

Kern River field, near
Bakersfield, Calif.

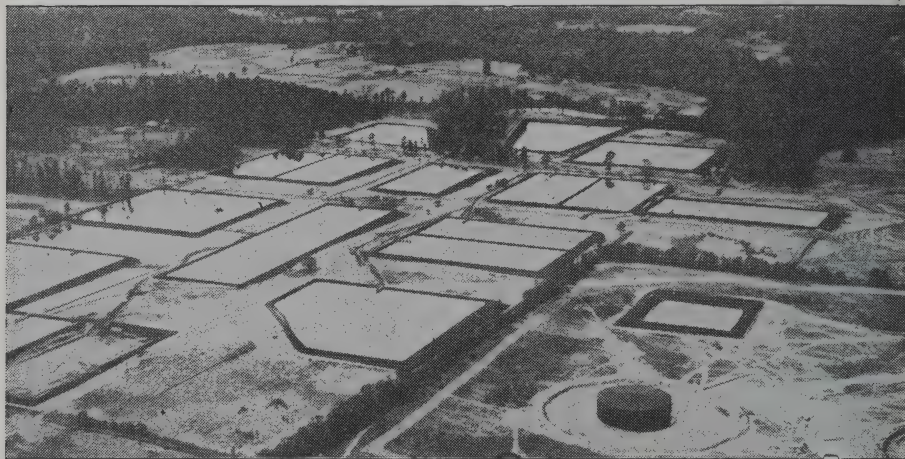
This oil contains very little
gasoline and kerosene and thus
the evaporation loss is low.

INTERIOR OF A HUGE CONCRETE LINED RESER- VOIR, ONE OF 5 IN A TANK FARM NEAR SAN PEDRO, CALIFORNIA

Capacity is 750,000 barrels
each or an average day's pro-
duction of the 10,000 Califor-
nia wells in 1923. Note the
roof supports and the chief en-
gineer, H. G. Smith.



—Union Oil Bulletin, July, 1923.



—Oil and Gas Journal.

WASTEFUL OPEN STORAGE OF CRUDE OIL CONTAINING LIGHT PRODUCTS, SMACKOVER, ARK., 1923.

While the bulk of the Smackover oil is heavy it is not as heavy as the Kern River oil of California and yields some gasoline and kerosene that is quickly lost through evaporation in open reservoirs.

and clogging up of sand pores and casing perforations with asphalt or paraffine.*

Stocks, Storage and Stabilization. Large stocks of crude oil carried above ground have the evident effect of steadying markets when the rate of production is either stationary or declining, and capacious storage facilities have the same effect in the face of a rising rate.† Storage construction has been stimulated perhaps to a point beyond future needs if the industry would but recognize the economic advantage of relying more upon the natural, inexpensive and non-wasteful storage underground. In 1923 it cost 27 cents a barrel or \$200,000 each to build permanent concrete reservoirs of 750,000 barrels capacity. During this closing year of tragic overproduction, the big companies in California kept their reserves underground as far as possible and bought their needed oil from the mushroom operators while awaiting better prices for their own product. It is of utmost economic importance to know that crude oil desirable for gasoline cannot be held long in storage to advantage or profit.

TREND OF CRUDE OIL STOCKS IN TERMS OF THE COUNTRY'S NEEDS

Year	Stocks, Dec. 31	Mos. Supply	Year	Stocks, Dec. 31	Mos. Supply
1909	117 mil. bbls.-----	8.4	1916	162 mil. bbls.-----	6.1
1910	131 " "-----	8.2	1917	146 " "-----	4.7
1911	137 " "-----	7.8	1918	122 " "-----	3.5
1912	123 " "-----	6.2	1919	128 " "-----	3.7
1913	123 " "-----	5.7	1920	146 " "-----	3.3
1914	142 " "-----	6.5	1921	191 " "-----	4.5
1915	164 " "-----	7.2	1922	265 " "-----	5.4
7 years' average-----		7.2	7 years' average-----		4.5

On September 1, 1923, the stocks of crude petroleum held elsewhere than on leaseholds in California and at refineries throughout the United States aggregated 298 million barrels. This was sufficient for 5 months' consumption at 59.5 barrels per month, the average for June, July and August.

To provide for all contingencies, such as war or a geological catastrophe, it would not be unreasonable for this country to carry a reserve supply of petroleum and its products equal to a year's consumption (if it were not so immense).‡ This has always been referred to as something impossible in view of the mounting domestic demand. Below is summarized

**The Lamp*, house organ of the Standard of N. J., Dec., 1922, answers the query, How can an oil-producing concern slow down and reduce its output when there is an excess of oil? with two suggestions: (1) Cease sinking new wells if his property is not all drilled up; and (2) if lucky enough to own all of a pool he could tap it as desired, closing his wells when the prices were unsatisfactory or speeding up production when they were advancing. Unfortunately, almost all important producing territory is divided among many owners or lessees; and so long as one of them produces regardless of market conditions the others must follow suit or see their oil underground taken away from them. Arnold has condemned our present leasing system as inconsistent with ideas of conservation.

†Read "Storage as a Relief for Overproduction," *The Oil Age*, Sept., 1922, p. 15.

‡*Oil. Paint and Drug Reporter*, June 11, 1923, page 45.

in round numbers the inventory of all forms of mineral oil in the United States as of September 1, 1923.*

	Mil. Bbls.
Domestic pipe-line and tank-farm stocks plus imports (U. S. G. S.)	298
Crude oil held at refineries (84% domestic, 16% Mex., Bur. Mines)	34.3
Total crude petroleum, except most producers' lease stocks	332.3
Partly refined oils held at refineries (Bureau of Mines)	30.7
Total crude oil and other unfinished forms	363.0
Finished Products (Bureau of Mines):	
Gas and fuel oils (1462.2 million gallons at 42 gallons a barrel)	34.9
Gasoline (1053.9 " " " 42 " " ")	25.0
Kerosene (243.6 " " " 42 " " ")	5.8
Lubricants (220.4 " " " 42 " " ")	5.2
All others (31.0 " " " 42 " " ")	0.7

(Total 3011.1 mil. gals., or 71.6 mil. bbls. fin. prod.)

Grand total stocks of crude, partly refined and finished 434.6

Finished products not susceptible to liquid measurement included 128,000 short tons of asphalt, 87,500 tons of wax and 20,500 tons of coke. The average monthly **rate of increase** in pipe-line and tank-farm stocks plus imports has been as follows, in millions of barrels since the depletion period of 1915-1918: 0.5 in 1919 (over 1918); 1.5, 1920; 3.8, 1921; 6.2, 1922, and 5.6, 1923, based on the first eight months' accumulation. It will be noted from the second preceding table that the stocks of crude not at refineries have more than doubled in about nine years; nevertheless we have ahead one month's supply less than we had at the end of 1914, or three months' supply less than we had at the end of 1909, notwithstanding the tremendous gain in production in 1923—almost 500 million barrels beyond that of 1914, or 575 million beyond that of 1909!

THE REFINING INDUSTRY

Manufacturing Operations and Refined Products. Advanced information from the Department of Commerce† indicates that petroleum refining now ranks above all other manufacturing industries, except "Slaughtering and Meat-packing" in point of value of products. Expressed in millions of dollars these values for the 12 leading industries in 1921 were as follows:

1. Slaughtering and meat-packing—\$2,201	8. Flour and grist, mills—\$1,180
2. Petroleum refining—1,727	9. Printing and publishing periodicals—1,124
3. Automobiles (including trucks)—1,671	10. Bread and bakery shops—1,090
4. Foundry and machine shops—1,565	11. Women's clothes making—1,023
5. Steel Works and rolling mills—1,482	12. Men's clothes making—935
6. Cotton mills—1,278	
7. Railway repair shops—1,180	
Total for 12 industries—\$16,456	

Petroleum refining precedes all these industries in respect to the value of output per wage earner. The Manufacture of motor

* C. O. Wilson's figures for this date, Sept. 1, 1923, published in *The Oil and Gas Journal*, Sept. 13, differ slightly from the author's. His sources are probably the same, U. S. Geological Survey and Bureau of Mines; but he evidently includes all stocks held on leases and markets in order to arrive at the greater grand total of 445.6 million barrels. His pipe-line statistics are gross, thus a few millions more than the net figures of the Survey.

† Courtesy of Eugene F. Hartley, Chief Statistician for Manufacturers, Bureau of the Census.

vehicles is looked upon as highly efficient, but its 143,658 wage earners in 1921 averaged only \$11,640 each compared with \$27,340 for each of the 63,189 employed in petroleum refining. In that year there were 366 petroleum refineries in operation and 385 establishments making automobiles. The number of different individuals or corporations operating refineries in 1919 was probably less than three hundred* compared with 9,814 operators in the natural resources of both gas and petroleum.

Petroleum refining has grown more rapidly than any other branch of manufacturing except automobile making.*

Census Year	Wage Earners	Value of Products	Census Year	Wage Earners	Value of Products
1859-----	1,473	\$6.4 million	1904-----	16,770	\$175 million
1869-----	1,870	26.9 "	1909-----	13,929	237 "
1879-----	9,869	43.7 "	1914-----	25,366	396 "
1889-----	11,403	85.0 "	1919-----	58,889	1,633 "
1899-----	12,199	123.9 "	1921-----	63,189	1,727 "

The gain in the 10 years, 1909-1919 was 323 per cent for wage earners and 590 per cent for value of products.

Herewith are tabulated the actual quantities of the different refined products and their total values for the year 1921, as published by the Bureau of the Census in 1923:

Refinery Products	Million Gallons	Value Millions	Unit Value Cents
Gasoline -----	5,098	\$ 840.7	16.45
Naptha, benzine, etc. -----	275.2	40.7	14.8
Total lightest products†-----	5,373.2	\$ 881.4	16.4
Residual fuel oil -----	6,894.5	232.4	3.3
Gas oils -----	1,634.3	85.3	5.2
Distillates -----	1,220.3	59.6	4.9
Total fuel bills -----	9,749.1	\$ 377.3	3.87
Illuminating oils (kerosene) -----	1,963.8	\$ 152.5	7.8
Lubricating oils -----	949.2	194.6	20.5
Total, four major products-----	18,035.3	\$1,605.8	8.9
Greases (petrolatum, axle g., etc.) -----	24.4	\$ 9.8	40.0
Asphaltic road oils -----	168.4	7.8	4.6
All other products (wax, asphalt, coke, candles, etc.) -----	*	104.1	---
Total by-products‡-----	(4.0 mil. tons)	\$121.7	(\$39.20 a ton)

* In 1919 138 refining companies ran 84 per cent of the total refined crude through their stills; probably no more than 162 smaller operators refined the remaining 16 per cent. On January 1, 1922, according to the Bureau of Mines, there were 270 different active operators of 325 plants with a combined refining capacity of 1,854,590 barrels per day. At the same time there were shut down 154 refineries of 254,610 barrels daily capacity. See Chapter VIII for their geographic distribution.

† These may all be considered as gas-engine or motor fuels—"motor spirits" as they are designated in the British Empire.

‡ In the absence of Census details, the author has apportioned these approximately: asphalt—1,200,000 short tons; coke—1,000,000; paraffin wax—225,000; besides the 575,000 tons of asphaltic oils and 100,000 tons of greases above expressed in gallons; and miscellaneous—900,000 tons. The unit values have been determined by the author. The percentage relations in quantity are shown at the end of Chapter IV.

Converting the liquid measure of the major products into short tons—about 63 million tons—and adding this to the weight of the by-products makes but 66 million tons, or roughly, 13 million tons less than the yield of crude in 1921. Part of this difference is due to direct consumption of crude; part is accounted for in crude run into storage instead of into stills, in losses of liquid from leakage and evaporation, and in worthless residues. If these figures are correct, they indicate that by-products constituted 6 per cent of the weight, or likely little more than 5 per cent of the bulk, but contributed 7 per cent to the total value of refinery products in 1921.*

A Chronic Problem. Fundamentally the refining of petroleum is unlike any other process of manufacturing except meat-packing. From the raw product of the mine, the forest, or the field the manufacturer need produce only the article or thing that his consuming public may prefer, whether radio sets, steel plates, fancy shoes or fine furniture. His basic raw material does not change and his apparatus, process and methods can be standardized. Not so with the oil refiner as his raw product changes with the discovery of each new pool and usually presents a new refining problem. During the first fifty years' growth of the industry, kerosene was the primary product and processes were developed for its maximum yield. From a market requirement of 58 per cent kerosene and 9 per cent gasoline in 1900 there was a change to a demand for 24 per cent kerosene and 26 per cent gasoline in 1914.†

Not commercially correct but economically true are the following relations, according to Pogue: Gasoline receipts pay for the raw material; kerosene for refining, and fuel oil for marketing, leaving the receipts from lubricants as profit. He concludes that skimming plants are profitable only in periods of flush production. In Texas alone, on January 1, 1922, there were 46 such plants shut down out of 97 refineries exclusive of eight skimming or topping plants being built. Such evidences of inexperience, miscalculation or mismanagement are monuments similar to the many milling and reduction plants that dot the gold and silver districts of the West where deep exploration did not precede construction. As a whole, the industry has to stand the expense of these emblems of tragedy as it has also to cover the cost of the numerous dry wells drilled each year.

*The petroleum refining activity is the largest and one of the most efficient chemically controlled industries in the United States. Yet while the most competent branches of the activity have carried the production of the main products forward with effectiveness, they have not been able, alone, to draw more than a modicum of value from the by-product possibilities inherent in the resource. During the past only 10 per cent of the total value ascribed to refined products was credited to some 200 by-products which made up 15 per cent of the total bulk (not weight) of products and waste. The waste made 5 per cent of the total. The cost of refining has been borne by the four main products—gasoline, kerosene, fuel oil, and lubricants—which constituted 90 per cent of the value and made up 80 per cent of the bulk, until more recently, as shown above. See part 6, bulletin 102, National Museum, by Gilbert and Pogue, 1918.

†E. M. Clark in *The Lamp*, February, 1913. In minor disagreement—as to designation—F. A. Howard wrote in *The Oil and Gas Journal* for Dec. 9, 1921: "Not manufacturing, but merely the separation of crude petroleum into its parts and then cleaning and polishing the parts."

True Cost of Refined Products. Because of these and other conditions it becomes very difficult to determine the true cost of gasoline and other refined products, as brought out before the hearings of the Senate Subcommittee on Manufactures. One of the witnesses, Mr. Coombe, of Ohio, likened the problem of costs of various oil products to the problem of a butcher who buys a whole beef and cannot determine what the porterhouse in it costs compared with soup bone: The demand for the porterhouse carries the soup bone (which is often thrown away); the demand for gasoline carries (in part) other petroleum products. This expert had studied it for years with discouraging results. Engineers for the Federal Trade Commission, after intensive study during the war, found it impossible to get at the true cost of gasoline in particular. The Census of 1919 made no effort to spread the costs over the different products, giving only the costs for the refining industry as a whole. Itemized, these were:

365.3 million barrels crude petroleum, at \$2.38-----	\$867,646,475
43.1 million barrels distillates-----	151,824,598
7.0 million barrels casing-head gasoline-----	59,857,628
16.7 million thousand feet ³ or cubic feet wet natural gas-----	1,256,834
Chemicals:	
45.3 million pounds caustic soda-----	1,736,670
503,920 short tons sulphuric acid-----	10,327,060
26,275 short tons pyrites-----	224,700
5,241 short tons sulphur-----	136,828
? other chemicals-----	663,660
Fuller's earth (for filtering)-----	2,375,729
Containers and materials therefor:	
Wooden, \$34,801,732; metal, \$26,193,075; total-----	60,994,807
All other materials-----	37,358,257
Fuel and rent of power-----	53,505,109

Total cost of material, containers, fuel and power----- \$1,247,908,355

Unit cost of the 415 million barrels of liquid petroleum----- \$3.00

The above unit cost allows nothing for depreciation of plant, expenditure for labor, and various outlays for overhead charges, which altogether have to come out of the \$384,624,411 value added by manufacturing according to the same Census.

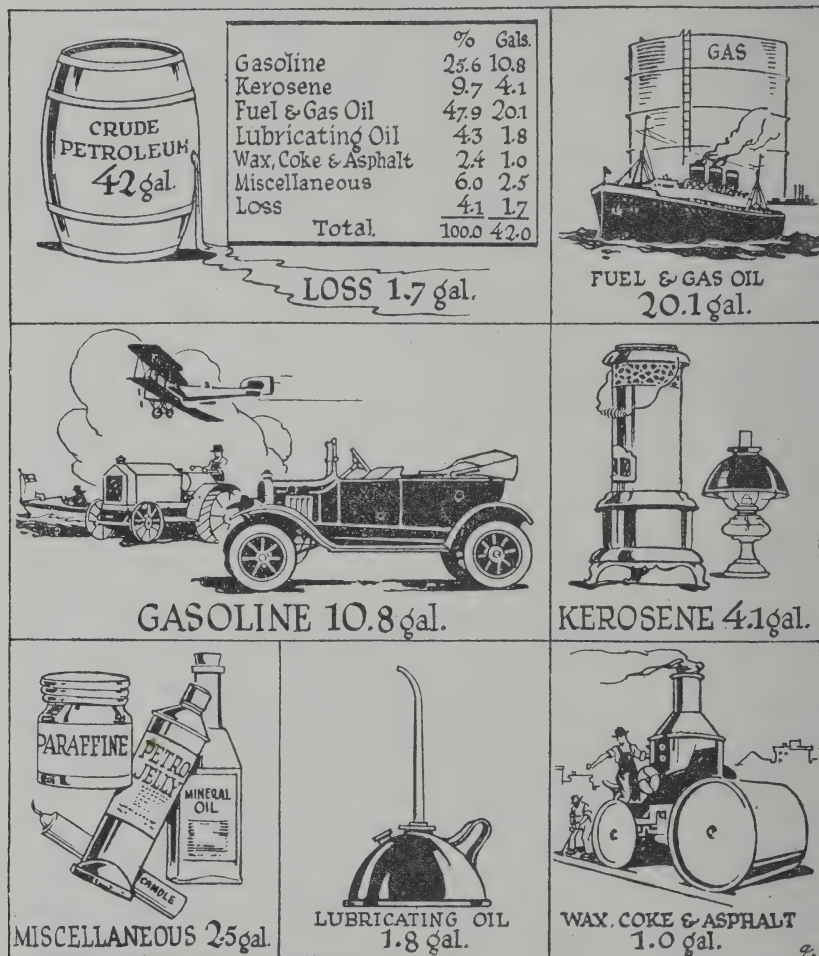
Present Rate of Yield in Major Products. The average daily rate of refining during July and August, 1923, was equivalent to annual rates as follows for the four leading refinery products, based on the latest Bureau of Mines statistics,* which indicate that the quantity of crude run through the stills this year will approximate 615 million barrels, including imported oil to the extent of 4 per cent:

Refinery Product	Million Gallons	Million Bbls.	Per Cent of Crude
Gasoline -----	7,570	180	29.4
Kerosene -----	2,210	52.5	8.6
Gas and Fuel Oils-----	12,150	290	47.5
Lubricants -----	1,070	25.5	4.2
Total, Four Major Products-----	23,000	548	89.7

From the above it appears that twice as much kerosene as lubricants is being produced; more than twice as much gasoline as of the former two

*Compiled by W. C. Hill, Petroleum Economist, Department of Interior.

together; and almost four times as much gas and fuel oils. Compared with 481 million barrels of the same products obtained in 1922 the apparent increase is only 14 per cent as a whole; but for gasoline the increase is 22 per cent, the yield being 147.6 million barrels or 6,202 million gallons in 1922.



WHAT THE REFINERS GOT OUT OF A BARREL OF CRUDE ABOUT TWO YEARS AGO

Less gasoline than now, but more kerosene and lubricating oil

Because of the stimulus to refinery construction in California the daily potential of all the refineries in actual operation must now, towards the end of 1923, be nearly 2,100,000 barrels daily or 200,000 barrels short of the maximum daily production of crude oil. In general the actual runs make 70 to 80 per cent of the capacity, considering only the plants in operation. Counting all those being built, shut down, and in operation,

the aggregate number and capacity at the beginning of each of the past five years were: 1918, 267 plants, 1,186,000 barrels; 1919, 289—1,295,000; 1920, 472—1,530,000; 1921, 469—1,889,000; 1922, 509—2,164,000.*

TRANSPORTATION OF PETROLEUM

The liquidity of crude oil has led to the development of a remarkable system of transportation without parallel in its cheapness and efficiency. This system comprises a network of pipe lines spread over much of the country, supplemented by specially designed tank-steamers for coastwise and foreign trade. A relatively small quantity of crude is handled by the railroads in tank-cars. To a preponderant degree, therefore, the movement of mineral oil is independent of the normal carrying agencies upon which commodities in general depend.†

Railway Transport. Tank-cars are mainly used for hauling refined products. During a recent period the railways derived 52 per cent of all their revenue freight from the products of mines, quarries and oil wells. Crude petroleum constituted only 1.2 per cent of the tonnage of these products, or 0.6 per cent of all the paying freight handled during that time by all the railways of the United States. The number of tank-cars in the United States and Canada on January 1, 1914, was nearly 50,000; seven years later the number had reached 137,500. In May, 1923, the Interstate Commerce Commission issued estimates of the revenue per car of various commodities on the basis of 1922 tonnage at 1923 rates. This revenue by the individual railway from petroleum was placed at \$86.28 compared with \$79.28 from anthracite, \$64.20 from asphaltum, \$63.17 from bituminous coal, \$45.17 from iron ore, and \$35.72 from gravel, sand and stone. The highest car rate for mineral products was from base bullion and matte, \$164.52. The three highest rates for agricultural products were from dried fruits, \$133.73; wheat, \$121.75, and citrus fruits \$115.41.

Pipe Lines. Before the advent of the tank-car, the tank-steamer, and the pipe line it was not an uncommon sight to see a string of half a hundred wagons hauling the oil from the wells to the refineries hundreds of miles distant. This furnished employment to many men and teams, and these men naturally became jealous of any system that meant the loss of their jobs. The result was that the pioneers' attempts to transport oil by

* Published January, 1923, in *Mining and Oil Bulletin*, of Los Angeles, and including data of small refineries that failed to answer the questionnaires sent out by the Bureau of Mines. Late in 1923 the potential of all refineries, whether operating or not, must be close to 2,300,000 barrels.

† Joseph E. Pogue's "Economics of Petroleum," John Wiley & Sons, 1921.

Alfred Liggett, Editor of the (London) *Petroleum Times*, wrote in his book, "Petroleum" (1919): "About 50 years ago a few master minds came to the front, and loyally supported by John D. Rockefeller, undertook the herculean task of practically girdling the United States with a system of oil pipe lines that has no parallel anywhere. They eliminated the jaded horses, oil boats, wooden tankage and slow freights—all tedious methods and questionable practice of handling petroleum—and substituted therefor the steampump, the iron conduit, the steel-tank storage and systematic and businesslike methods which soon commanded the confidence and respect of all oil-producers. They extended their pipe-lines to almost every producing well and established a transportation system which serves the industry to-day as no other on earth is served. The advantages of the modern pipe-line to the oil-producer (and indirectly to the investor) are very obvious."

pipe line were repeatedly made in vain, the lines being destroyed time after time. It was only by the constant guarding of the property that the system was finally placed upon a safe basis. Now millions of people walk and ride daily across these underground conduits, unconscious of the fact that beneath their feet is flowing the crude product on its way to be refined for use in running and oiling their motor cars and in lighting or heating their homes.*

These buried pipe lines now carry to refineries nearly all the petroleum† discharged by the 300,000 live wells in the United States. They measure almost 60,000 miles, three-fourths being main or trunk lines. Their aggregate length makes over one-fifth that of the railways or sufficient two and one-half times to belt the earth at the Equator. Unlike the railways, whose routes are controlled largely by relief, the pipe lines extend in fairly straight courses.

Through an act of Congress the pipe lines must be operated as common carriers. In common with the railways they are supervised by the Interstate Commerce Commission "for the purpose of assuring that the charges and facilities for transportation shall be reasonable and that there shall be no discrimination between shippers." As a rule the tariff rates of the trunk pipe lines have ranged from 50 to 70 per cent of the railway rates for shipping crude oil the same distances. In 1916 it cost the shipper 70 cents to "pipe" the oil from the Cushing pool in Creek County, Oklahoma, to either Baltimore, Md., or Bayonne, N. J. Local gathering-line cost per barrel has rarely been less than 4 or 5 cents. As of January 1, 1922, the 33 principal pipe-line companies in this country reported \$365,000,000 invested in pipe lines alone besides \$287,100,000 in tank farms and other facilities.

Tanker Transport. While pipe-line transport of refined oils in particular is less expensive than railway haulage in either tank cars or small containers, water transport of any kind of oil in bulk is by far the cheapest method of moving it to market or refinery. For instance, in July, 1923, gasoline bringing 10 cents a gallon at Oklahoma refineries could not be laid down at New York under 15 cents, while California gasoline could be delivered there at 12 cents, although it must be carried nearly three times the distance.‡ In fact, at no time is it as economical to carry crude by pipe line when water transport is available.

Prior to the development of the bulk-oil carrier, practically all shipping was done in barrels and in wood-enclosed cans, the latter known as "case oil." In 1885, about five million barrels were exported in barrels but only forty thousand in bulk; less than twelve years later, shipments in barrels had dropped to forty thousand while the transport of bulk oil had risen to 11.5 million barrels, thus more than reversing the ratio. "Gluckauf," first modern tanker, was built in England in 1866. It was provided with a safety space between the boiler room and the oil storage,

*"Wages and Hours of Labor in the Petroleum Industry", Department of Labor.

†They do not carry the oil all the way to the refineries; in some cases only to tide water for further and principal transport by tankers. In the case of the new California fields the distance is less than 15 miles on the average as two of them, Long Beach and Huntington Beach, are situated on the seacoast.

‡N. O. Fanning's "Transportation Costs of Refined Oils," *Oil and Gas Journal*, Aug. 2, 1923.

allowance for expansion of the oil when heated, and reduction in the danger of the oil shifting with the roll and pitch of the vessel, thus differing from those earlier built to carry the liquid next to the "skin" of the ship. Since that year the increase in size has been no less remarkable than the growth in the number of tankers. The greatest impulse to this arose with war time requirements. Before 1915, the average deadweight of bulk-oil steamers was less than 6,000 tons, but now it is nearly 10,000 tons or 60,000 barrels. The largest tanker, the S. S. "William Rockefeller," registers 20,000 tons and has a capacity of 140,000 barrels.*

During 1919 and 1920 also, there was a big gain in tank steamers, due mainly to the expansion in imports from Mexico. All the big oil companies using them added greatly to their tonnage and at the same time the U. S. Shipping Board built some 80 oil tankers. But in 1921 a collapse occurred in the oil markets, and much of the new tonnage went out of use and nearly all the boats of the Shipping Board were tied up. Early in 1923, the trade between California and the East through the Panama Canal began to grow so great because of the unexpected flood from the new fields of the Los Angeles basin, that all available tankers were required. The Shipping Board was enabled to charter its idle vessels at high rates—up to 90 cents a barrel—and to sell many of them, at the low price, however, of \$35 to \$40 per ton. Before September, about 55 of the government tankers were taken over by private interests besides those under charter.†

The ocean rate on crude from California to the North Atlantic was 82 cents about September 1, 1923, a 27 per cent drop from the peak of \$1.12 reached last May. The decline was partly the cause and partly the result

* John G. Pew's "Modern Tank Steamers", *Mining and Metallurgy*, December, 1922.

† "World Shipping Turns to Oil", *The Oil and Gas Journal*, Sept. 6, 1923.



TWO U. S. SHIPPING BOARD TANKERS AT MOBILE, ALA., SOLD DEC. 30, 1922, TO THE UNION OIL CO. OF CALIF. GROSS TONNAGE ABOUT 7,075 EACH; CAPACITY ABOUT 70,000 BARRELS EACH.
—Courtesy of Union Oil Bulletin.

of the demoralization of the oil industry traceable to over-production. For October, 1923, the rate was even lower, only 70 cents, and applied as well to gasoline as to crude for loading at San Pedro, California, as far ahead as January, 1924,* Early in October a Norwegian tanker was engaged to take crude from Tampico, Mexico, to Fall River, Mass., at only 27 cents a barrel compared with this year's high of 50 cents. The continued reduction is due no doubt to the over supply of tanker tonnage; over 400 bulk-oil ships being on the California run alone late in August with the competing operators realizing that a slackening demand is sure to come sooner or later.† The latest cuts made it possible to move gasoline at a cost of 2 cents from California where it could be bought in bulk at 6 cents, making the total 8 cents a gallon at New York. This will likely never happen again in the history of petroleum.

NUMBER AND TONNAGE OF THE WORLD'S TANKERS, JUNE 30, 1923.

(Bureau of Navigation, Dept. of Com., 9-1-'23.)

Flag	Number	Thousand Gross Tons	Flag	Number	Thousand Gross Tons
American -----	466	2,470	Italian -----	18	75
British -----	367	1,894	Japanese -----	10	58
Norwegian -----	37	195	German -----	10	34
Dutch -----	43	126	Belgian -----	8	37
French -----	23	111	Danzig -----	4	36

Twenty-six countries altogether had 1,036 bulk-oil vessels with a combined gross tonnage of 5,160,534 at the middle of 1923. Those of less than 500 tons were not included in these totals, which, however, did include 98 sail and barge vessels of 147,050 tons. The United States with 47.8 per cent, Great Britain with 36.7 per cent, and Norway with 3.8 per cent, together controlled 88.3 per cent of the world's oil tankers which, in turn, made up 8 per cent of the world's entire shipping (33,507 steam, gas, and sail vessels of 100 or more gross tons each and totalling 65,166,238 tons) on June 30, 1923. During the nine preceding years the number of tankers had increased 183 per cent—from 366—and the gross tonnage 258 per cent—from 1,441,196 gross tons. The Bureau of Navigation has taken its statistics from Lloyd's Register, except those pertaining to the United States, and they all exclude Navy, Admiralty, and other Government tankers.‡

* *Wall Street Journal*, October 17, 1923.

† Although tanker transport is economical it (usually) makes up about half the cost of California oil delivered at the North Atlantic refineries. The round voyage takes 42 days, including 2 days for twice traversing the Canal. To cover the distance of 10,000 miles means the burning of 1,700 tons of fuel oil, the eating of 5,000 meals plus night lunches, the paying of \$5,000 in wages and an average of \$15,000 to \$20,000 in Canal tolls.—*The Lamp*, W. F. Dunning, December, 1922. In 1921 it cost \$3,250,000 to build the tanker "Tamiahua" of 16,340 tons deadweight or 100,000 barrels capacity, making \$32.50 a ton. According to the *Wall Street Journal* the cost of building in American yards now averages \$80 a ton, compared with British building cost of about \$65, referring presumably to gross tons, making the cost less for a deadweight ton.

‡ *The Lamp* of June, 1923, reports 969 tank steamers of 7,723,951 deadweight tons, which, at 6 barrels to the ton would make a total carrying capacity of about 46,350,000 barrels for the world's tanker fleet, evidently not counting the sail ships and barges, but including some idle steamers.

DISTRIBUTION AND UTILIZATION.

Distributing and Marketing Products. Great differences exist between the marketing agencies and conditions of the crude oil industry and those of the refining industry. Due largely to the relatively huge number of producers, 16,000 in 1919 according to the Federal Trade Commission,* the business of crude production is on the whole inefficient in recovery, uneconomic in caring for the product, and highly competitive and therefore at times unprofitable in marketing. Transportation, refining and marketing of refined products are activities concentrated in the hands of a relatively small number of corporations. As a rule, the refiners market their own output, and the degree of concentration in refining—138 companies directly controlling 84 per cent of the refinery yield in 1919—is an index to the degree of concentration in the marketing of refined products.

Because crude production has grown more rapidly than the normal industrial development of the country, becoming a sort of free-for-all game, the petroleum interests have neglected it and instead, as Pogue says, paid unremitting attention to the means for extending the markets for the manufactured products. As a result of the competitive, individualistic methods of production in vogue, harmonizing with the unrestrained wild-cattling, there is usually present a plethora of raw material. To prevent a paucity in demand for all of the products and by-products, on the other hand, requires highly organized efforts.†

It is interesting to note that most of the thirty-two companies that each produced a million barrels or more and together 58 per cent of the crude in 1919, were either refiners (and marketers) or were practically identified with them through common stockholders and thus controlled 50 per cent of the refined products that year. Being engaged simultaneously in production and refining makes it possible for the integrated companies to benefit from the advance in the price of crude oil both as producers and refiners (as well as marketers) while those small refiners who do not produce crude complain that they are placed in a difficult position.

Marketing in general is in the hands of three groups: (1) Standard companies, (2) independents, and (3) jobbers. The Standard group, which runs through their stills a little less than half of the crude refined each year, usually distributes two-thirds of the gasoline, buying the difference from the independents. The independents, therefore, directly distribute relatively less gasoline but more of other products and the crude oil itself. The jobbers handle practically no crude oil and fuel oil, preferring the more profitable and attenuated distribution of gasoline, kerosene, and lubricants. In the marketing of gasoline in particular, the larger independents are aping the Standard group in perfecting systems of dis-

*Report in response to House Resolution No. 501, "Advance in the Price of Petroleum Products", pages 30-31, under "Competitive conditions in the marketing of crude oil", 1920, followed in 1921 by a report on the "Pacific Coast Petroleum Industry" which considers marketing and refining in the United States, pages 196-220. The Census Bureau gives only 9,814 producers of petroleum and natural gas in 1919, from less than 1 to about 70,000 barrels daily for each.

†To-day, therefore, the marketing of oil, with its preparatory steps of transportation and refining, is found to be a closely integrated enterprise, handling tremendous volumes of products, through diverging and ramifying channels of distribution of a unique and singularly efficient character.—Pogue's "Economics of Petroleum", page 213.

tribution for directly placing the refined products in the hands of consumers by means of service stations in the cities and tank wagons and tank stations in rural regions. The division of marketing territory among the Standard companies, continued since the Standard Oil dissolution in 1911, is shown on a map in Chapter VII in outline.

On account of the increasing competitive conditions* numerous special, local, regional and national organizations have sprung up during the last few years, largely for the purpose of stabilizing market conditions. Many States have their own marketers' associations, one of the youngest being formed in Indiana during September, 1922. The Mid-Continent Oil and



DISTRIBUTING STATION IN A FORMER DESERT
Union Oil Co.'s plant in the Imperial Valley, Calif.

Gas Association is probably the strongest of its kind in the country but was not organized before October, 1917. It had more than 2,000 members in March, 1923.† On February 17, 1923, nearly one hundred representatives of refiners, jobbers and marketers met at Chicago and formed the newest marketing "club"—the American Oil Men's Association—merger of two others, the National Petroleum Marketers' Association and the American Independent Petroleum Association.

Prices of Refined Products. There should no doubt be a definite relationship between the price of a crude oil and the prices of its various products.‡ This seems all the more reasonable in view of the unique fact that ordinarily the manufacturing consumer of the raw material (crude oil) fixes the price of that material.¶ This is certainly a saving influence

*For "Factors in Cost of Marketing", see page 16, *The Oil and Gas Journal*, May 3, 1923. For "Investment in Marketing Equipment", see Chapter XII hereof.

†Officers, 1921-1924: W. N. Davis, pres., W. B. Pyron and Chas. T. Wilson, v. presidents, H. H. Smith, sec.-treas. This influential body is credited with getting the following favorable report from the Federal Trade Commission: "It seems that there is a greater justification in assigning the advance in price of crude oil and petroleum products to varying conditions of supply and demand in the light of emphasized and pessimistic statements as to future of supply than to a combination in restraint of trade."—*Oil Trade Journal*, March, 1923.

‡C. M. Alexander, Gen. Mngr. Texas Oil Products Co., in *The Oil and Gas Journal*, Oct. 11, 1923.

¶ *Oil, Paint and Drug Reporter*, May 7, 1923, page 17.

in the industry, especially when it is possible to discourage over-production and waste through the cutting of prices from above. While the general trend of crude and of refined prices do not diverge greatly from that of all commodities from year to year, there are these two differences to be noted between the first two: (1) crude oil presents a much greater percentage range in price than do the refined products taken together, and (2) the prices of the products being apparently more stable they lag a little behind those of the crudes when the latter go either up or down.

For purpose of comparison the prices of Oklahoma oils, crude and refined, are herewith given according to The Oil and Gas Journal of October 18, 1923 (*wholesale or refinery prices during a period of depression*):

Grade of Crude Oil	Bbl.	Gal.		Refined Oil	Bbl.	Gal.	
		Cts.				Cts.	
Healdton, below 28° ----	\$0.50	1.2		Fuel, 26° -----	\$0.85	2	
" 28° to 30.9° ---	.70	1.7		Road oil 60° -----	1.05	2.5	
Mid-con. below 33° -----	.90	2.1		Kerosene dist. 44° ----	2.10	5	
" 33° to 39.9° ---	1.30	3.1		Gasoline 78° -----	3.36	8	
" 40° and above	1.75	4.2		Lube 200 vis. 23-28 cold test -----	6.30	15	

Consumption.* The U. S. Geological Survey publishes monthly statistics that indicate quantity of crude oil delivered to consumers by the pipe line and other marketing companies. These deliveries do not necessarily mean immediate consumption as considerable stocks must be carried by refiners and other consumers. Three classes of consumers of crude should be comprised within complete statistics of "Consumption." The most important factor is the refinery; next is the group using petroleum in its natural state for fuel purposes; and third is the export factor. The first and third are determinable with a fair degree of accuracy; the second is still definitely uncertain, but usually makes about one-fifth of the domestic production of crude oil.† The following analysis shows how the indicated deliveries of crude oil during September, 1923, were determined:

	Million Bbls.
Stocks of domestic and imported crude, Aug. 31, 1923-----	298.9
Domestic production during September-----	64.3
Imports during September (mainly from Mexico)-----	6.0
 Total supply available for demand-----	 369.2
Exports of crude during September----- 1.6 mil. bbls.	
Stocks of dom. and imp. crude September 30----- 307.2 mil. bbls.	308.8
 Difference—Indicated deliveries during September-----	 60.4
Average daily rate of indicated deliveries-----	2.0

*"In the consideration of any domestic industry the factor of home consumption must not be overlooked; indeed, home consumption is more directly connected with national welfare than exports."—George Otis Smith's "The Economic Limits to Domestic Independence in Minerals" in Mineral Resources of the United States, 1917.

† Report of the Federal Trade Commission on "The Advance in Price of Petroleum Products," 1920, page 26.

CONSUMPTION OF CRUDE OIL IN THE UNITED STATES BY MONTHS FOR 1923

(Expressed in thousands of barrels)

Month	Total	Daily Average	Month	Total	Daily Average
January -----	58,448	1,885.4	July -----	61,192	1,973.9
February -----	51,522	1,840.1	August -----	62,447	2,014.4
March -----	59,849	1,929.3	September -----	60,447	2,014.9
April -----	57,350	1,911.7	October -----	63,412	2,045.5
May -----	58,020	1,871.6	November -----	61,204	2,040.1
June -----	54,396	1,813.2	December -----		
First 6 months---	339,545	1,878.6	Second 6 months---	368,555	2,005.0
Partly estimated for the entire 12 months of 1923-----				708,100	1,940.0

Production gained slightly over consumption during September, bringing the stocks of crude oil in this country up to the highest figure in history, namely 307.2 million barrels. This quantity is additional to that held on leases and at refineries. The recent gain in consumption is almost marvelous—81 million barrels or 31.3 per cent, comparing the first half of 1923 with that of 1920. It was 117.4 million barrels or 45 per cent greater during the second half of 1923 than during the first half of 1920, based in part on an estimate for the last month of 1923.

CORRELATION OF MARKETED PRODUCTION WITH CONSUMPTION OF DOMESTIC CRUDE OIL

		(Millions of barrels)			
Year	Pro- duction	Consump- tion	Year	Pro- duction	Consump- tion
1910 -----	209.6	229.5	1917 -----	335.3	351.7
1911 -----	220.4	214.2	1918 -----	355.9	380.2
1912 -----	222.9	237.3	1919 -----	378.4	371.6
1913 -----	248.4	248.5	1920 -----	442.9	429.6*
1914 -----	265.8	247.0	1921 -----	472.2	406.8*
1915 -----	281.1	258.9	1922 -----	557.5	592.4
1916 -----	300.8	302.1	1923 -----	735	708.1*

Utilization.—Petroleum is used chiefly as a source of power, light, and lubricants, and these are the uses that everyone knows. Crude petroleum is used in decreasing quantities from year to year; and more and more of it is prepared for higher utilization by breaking it up into refined products of greater value. The light-gravity ethereal products are employed as local anesthetics. The gasolines are the universal fuels of internal combustion engines. The naphthas are extensively used as solvents and are blended with raw casing-head gasoline to make commercial gasoline. The kerosenes, though used chiefly for illumination, are employed increasingly as fuel for farm tractors. The lubricating oils and greases are indispensable to the operation of all kinds of machinery. The waxes derived from petroleum of paraffin base are utilized in many forms—as preservatives, as sources of illumination, and as constituents of surgical dressings made for the treatment of burns. Petroleum coke, an almost pure carbon, is used in metallurgy and in making battery carbons and arc-light pencils. By-product fuel oils obtained from refining are used for generating power by industrial plants, railroads, and ocean steamers. Road oils lay the dust on streets and highways, and artificial asphalt, a product of petroleum, has been used in some places for paving.†

*Exports of domestic crude oil are not included in the indicated consumption.

† Page 17, "World Atlas of Commercial Geology," Part I, U. S. Geol. Survey, 1921

There is a general agreement that lubrication is the most important and most irreplaceable application of all petroleum products. One is justified, therefore, in placing this requirement at the head of an **economic priority** list, as follows:

- | | | |
|------------------------|-------------------------|------------------------|
| 1. Lubrication | 5. Gas manufacture | 9. Merchant marine |
| 2. Illumination | 6. Gasoline manufacture | 10. Locomotive firing |
| 3. Chemical byproducts | 7. Diesel engines | 11. Steam-power plants |
| 4. Automotive engines | 8. Naval vessels | 12. Heating buildings* |



OUR NAVY NEEDS A LARGE RESERVE OF OIL

Naval vessels should be fueled and oiled ahead of the merchant marine, railways, steam-power plants, and domestic heaters. The U. S. Navy plans to store 50,000,000 bbls. of oil at a cost of \$103,000,000, payable in oil from naval reserves. (Wall St. Journal, Nov. 1, 1923.)

MAKING THE IGLOO COM- FORTABLE WITH KER- OSENE

A truthful picture of what may be seen along the Alaskan Coast and on the banks of the lower Yukon. The Eskimo's brace has displaced his bone drill and the rifle his harpoon. (Standard Oil Bulletin, 1917.)



*Abstracted from article by R. S. McBride in *Engineering and Mining Journal*, Oct. 30, 1920. Pogue says, in his "Economics of Petroleum," page 348: In addition to the fact that millions of barrels of potential lubricating oils are burned annually in the form of fuel oil, the application of lubricating oils is in many instances far from scientific. Losses arising from faulty or imperfect lubrication run from 10 to 50 per cent of the power consumed. . . . The life of lubricants has been lessened through crank-case dilution.



AN OIL-BURNING LOCOMOTIVE IN SOUTHERN CALIFORNIA

About 36 years ago oil was thus used for the first time, being introduced on California railways by Messrs. Hardison and Stewart when crude oil cost \$2.50 a barrel and coal \$22.00. (Union Oil Co. Bull., Oct., 1922.) American railways now burn 27 per cent of the coal and 8 per cent of the oil produced in the United States. It would be an economic crime for them to consume more fuel oil where coal is available.



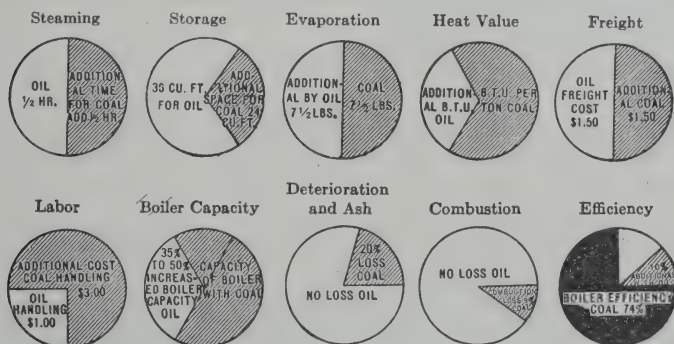
ARTIFICIAL AND NATIVE ASPHALTS ARE USED IN ROAD-BUILDING

The former represents the residuum in refining oils with asphalt base; the latter comes chiefly from Trinidad and California. Imported Mexican petroleum is the source of 60 per cent of our refinery asphalts. (Standard Oil Bulletin.)

What we need now is better and not faster utilization of petroleum. It is greatly to be regretted that in some parts of our country, particularly in the Southwest, from Texas to California, the last three uses above enumerated prevail to the almost entire exclusion of coal. The growing use of fuel oil for heating buildings in the East is directly due to the recent labor troubles in the anthracite industry. The principal railroads of the United States consumed practically 45 million barrels of fuel oil in 1922, an increase of 4 million barrels in one year. Steam-power and other plants producing electric power utilized in 1922 13.2 million barrels of fuel oil besides 27,172 million cubic feet of natural gas. There is absolutely no excuse for burning unrefined oil when fuel oil may be obtained at 60 per cent of the price of the crude according to 1922 contracts of the Santa Fe and other railway companies that buy liquid fuel from the Mid-Continent refineries. It is interesting to note that 440 million barrels, or ten times the present rate of consumption, would be required by the railways if all our locomotives burned oil. During 1922 about 52 million barrels of fuel oil were delivered for ships' bunkers at ports and insular possessions of the United States, an increase of 9 millions or nearly 21 per cent in one year. The U. S. Navy took 5.8 million barrels, making a total of 57.8 million barrels, for marine and naval purposes. Of this total 60 per cent was of Mexican origin,

COAL VERSUS OIL

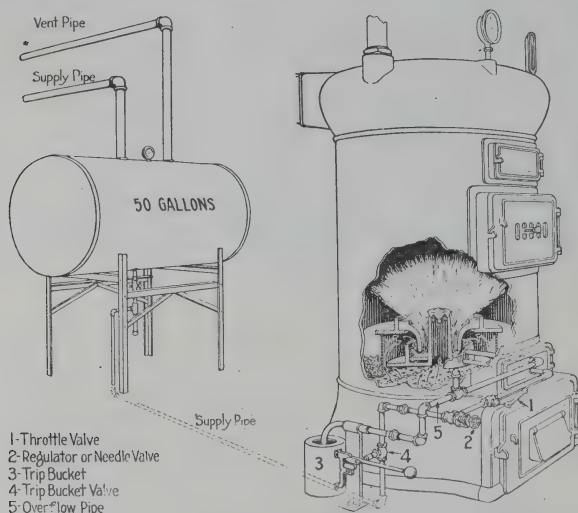
Coal the Chief Rival of Petroleum. The coal and petroleum industries are closely interrelated. Coal and petroleum are largely interchangeable as sources of energy. Both can be used in their crude state for fuel under boilers, although crude oil is the more efficient; both provide an illuminating oil for use in lamps, although kerosene is so much better than coal oil as to have driven it out of the market; both furnish a satisfactory fuel for the internal-combustion engine, although benzol, a coal derivative, has not yet been recovered in sufficient quantities to make it a competitor of gasoline; both provide a fuel gas, although that derived



GRAPHIC COMPARISON OF THE EFFICIENCY OF COAL AND OIL AS FUEL; AFTER TIDE WATER OIL CO.*

* Reprinted by permission from Pogue's "Economics of Petroleum," published by John Wiley and Sons, Inc.

from petroleum has the greater heat value. Ton for ton, petroleum has every advantage over coal, and there is every reason why it should drive coal out of its present preeminent position in industry, except one—the limitations of the supply. Not only in terms of money, but in terms of human effort and life, is the liquid fuel far cheaper to produce.* As a matter of fact, however, petroleum cannot be expected radically to displace coal in industry and transportation, since a crude petroleum production of about 3,000 million barrels a year would be required to drive coal from its ascendancy.† That quantity is four times the enormous yield from all the 300,000 live oil wells in the United States during the year 1923.



HOUSEHOLD HEATING WITH OIL

Low-priced Kerosene or furnace (not fuel) oil is used in this particular type of oil burner. At 10 cents a gallon, 120 gallons cost less than the equivalent ton of coal at \$16. Moreover, an oil burner is without smell, smoke, dust and ashes; it heats evenly without attention; but it costs from \$200 to \$350 including installation.‡

Three things distinguish the domestic from the commercial type of burner; Automatic start and stop; automatic ignition, and safety devices for stopping the feed if ignition fails.

Displacement of Coal During 1923. As a result largely of labor troubles in the coal fields of Missouri, Kansas, Arkansas and Oklahoma, and of over-production in the oil fields west of the Mississippi, almost 10,000,000 tons of coal were displaced by oil or gas in the mid-continent region alone during the year just ended. More than a million tons was displaced by oil in public utilities alone in the four States named. In Kansas City half a million tons is now eliminated by gas, which also has displaced 1½ million tons in Arkansas and Texas. High costs and uncertainty of supplies have induced these railways to change from coal to oil: the Rock Island, the 'Frisco, the Cotton Belt, the M.-K.-T., the Santa Fe and the Missouri Pacific.¶

*"The Coming of Coal," p. 83. This excellent book of 113 pages was prepared by Robert W. Bruere for the Educational Committee of the Commission on the Church and Social Service of the Federal Council of the Churches of Christ in America, Association Press, 347 Madison Ave., New York.

† Pogue's "Economics of Petroleum," p. 330.

‡ (Quinn burner) Better Homes Equipment Co., Baltimore and Washington. Another type has been designed by E. B. Ericksen, 142 Clifton Place, Brooklyn.

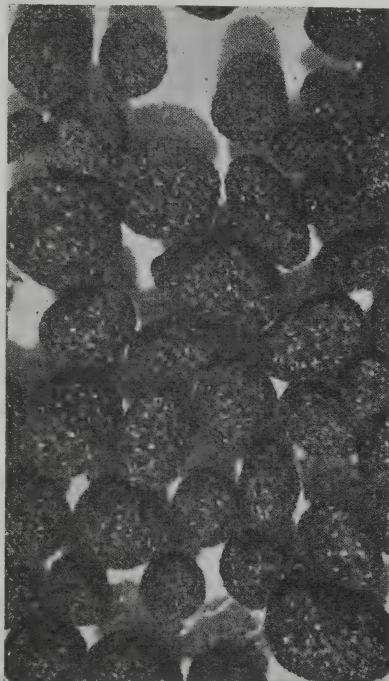
¶ In the San Francisco Chronicle, Aug. 30, 1923, G. E. Laughery, financial editor, wrote that New England has altogether (in very recent years) supplanted 25,000,000 tons of coal annually with oil. Read "Hastening the Downfall of King Coal" in the Literary Digest, Sept. 8, 1923. According to *The Oil Weekly*, Dec. 22, 1923, the conversion of the Tex.-Okla. division of the Rock Island alone will require ¾ of a million barrels of oil yearly.

Heating Buildings. Although this use is the last to be recommended according to the priority list on a preceding page, the tendency of 1922 has continued throughout 1923 in the way of introducing oil burners for the heating of buildings. Notwithstanding the approval of insurance companies, the New York city authorities have discouraged, however, the storage of as much as 50 gallons of distillates, such as low grade kerosene, in the basements where coal furnaces have been converted to oil burning. Such objection will no doubt be overcome by using heavier or less volatile fuel oil. No prejudice exists for instance in Kansas City where more than 15,000 oil burners have been installed in apartments and residences.*

AMALGAMATING COAL AND OIL BENEFITS THE OIL BUSINESS

Advantages to the oil industry of the processing of oil combined with coal: (1) Heavy cheap oils, on account of their high pitch content, become more useful for making coke than the light expensive oils; (2) the residues after distilling light oils can be more efficiently utilized for making mixtures for the production of gas, motor fuel, and coke, than for direct combustion. A ton of oil will collect all the combustible from 5 tons of low-grade coal and make 5 tons of concentrated solid fuel.—Millions of tons of oils with too much associated water exist in many oil fields and are salable only to combine with coal (Walter E. Trent's "The Fuel Problem of the United States," in the *National Magazine*, Nov. 1923).

The Trent process consists in stirring together water, oil and powdered coal. This yields a partly de-ashed plastic fuel, called an amalgam, the oil selecting the coal particles and largely excluding the water and ash. The amalgam is mechanically freed from water in the same way that butter is worked. It can be fed to the furnace by shoveling or by forcing through pipes; and if desired, it can be safely stored under water. (O. F. Hood, chief mech. engr., Bureau of Mines, "The Use of Oil in Cleaning Coal," *Chemical and Metallurgical Engineering*, Aug. 3, 1921).



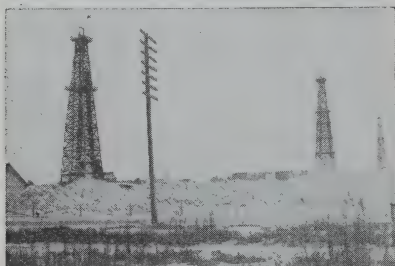
Co-operation of the Coal and Oil Industries. Both profit and popularity will come to the producers of coal and of oil alike if the waste material of the one and the salt-water and oil emulsions of the other can be cleansed and combined to form marketable products that can be sold for domestic purposes in particular at prices noticeably lower than those of anthracite or of the superior grades of bituminous coals. Even better would it be if coke instead of raw coal and unrefined oil were used in this

* The two preceding paragraphs are based mostly on data reported to the now defunct U. S. Coal Commission. In *The Saturday Evening Post*, Oct. 14, 1922, Floyd W. Parsons wrote as follows on the subject of "Coal Remedies": Oil for heating homes, factories and other buildings is not in the experimental stage, for some of the great sky-scrapers, hospitals and department stores, as well as homes in New York and other cities, have long ago gone over to an oil diet and dispensed with their coal bins. *The Oil and Gas Journal*, August 23, 1923, stated that the saving to the Ritz-Carlton Hotel during six months after conversion amounted to \$25,490; and that the New York prices at the middle of 1923 ranged from 4½ cents a gallon for heavy Mexican oil for use in big buildings, to 9 or 10 cents a gallon for refined (burning) oils for use in smaller furnaces.

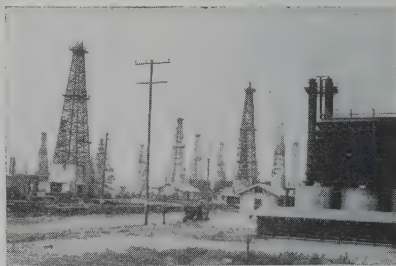
way, for then the dyes, the benzol, the ammonia, and the gas for cooking would not be lost. It looks now as if solutions to their conservation and cost problems have been worked out to apply on a commercial scale. One of the practical solutions is illustrated herewith.*

WASTE, CONSERVATION, AND MONOPOLIES

Tragic Waste of Petroleum. The heaviest losses of the natural resources are sustained underground as a result of the destructive competitive drilling and the ineffective methods of production. But the losses due to inadequate methods of handling the product upon reaching the surface are far more sensational because they can be seen. Surface losses are greatest in new fields and arise from forcing production before handling and storing facilities are ready. Thus some of the oil escapes capture, sinking into the soil or flowing down streams; great quantities of the more valuable parts evaporate into the air;† while fires are blamed



ECONOMIC TRAGEDY



ECONOMIC TREASURE

A great deal of good gas was wasted when a well of the Union Oil Co. of Calif. blew up at Santa Fe Springs in 1923. Note the material built up around this gas crater. In many fields away from population centers natural gas escapes into the air. In some places it is made the source of carbon black, as in the great Monroe gas field, Louisiana. In the view at the right appears part of a plant at Santa Fe Springs for extracting the gasoline content before the gas is burned. (See following chapter and *Mining and Oil Bulletin*, Dec., 1922.)

for wastes unmeasurable but immense. Also, enormous volumes of natural gas accompanying the oil are allowed to escape in the absence of an adequate demand for this product.

Losses of oil occur not only in producing but in storing, transporting and refining the raw product. In some cases 20 per cent of the gasoline content evaporates in storage. Despite the high efficiency of pipe-line transport it is estimated that 2 per cent of the oil is lost in trunk and gathering lines through leakage and evaporation. Tank cars not insulated

* Another solution may be the one described by Lindon W. Bates in the *National Petroleum News*, August 16, 1922.

On page 63 appears a comparison of the coal and oil industries as to total value and output per man. A more complete economic study of coal and oil will be the subject of a forthcoming book under the major authorship of President Frank L. McVey of the University of Kentucky.

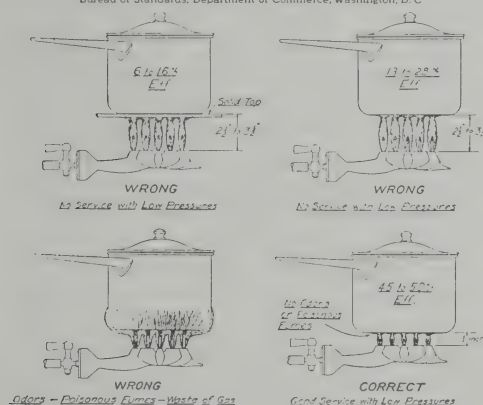
† The Bureau of Mines states that the entirely preventive losses in the evaporation of gasoline from crude petroleum from the time it leaves the wells until it arrives at the refineries totals yearly more than 300 million gallons, or enough to supply 1,250,000 autos at 250 gallons a year.

lose gasoline in summer time at the rate of 1 per cent per day. Of the customary 4 per cent waste in refining about half, in the form of gasoline vapor, could be saved. The greatest waste above ground, however, takes place in the utilization of gasoline, fuel oil and lubricants. Thirty per cent of the heat units in the gasoline goes into the exhaust of the average automobile (see Chapter VII). According to the Bureau of Mines,* 25 per cent of the fuel oil consumed for steam-raising is wasted through improper operation of plant. The most criminal economic waste, next to the underground losses, lies in allowing any oil with a lubricating element to be burned before refining.

Conservation. If the sub-surface products of the earth's development through vast periods of time should be exhausted, whether by waste or by use, civilization would fall back upon material bases little better than mankind had in the Stone Age.† It cannot be pointed out too often that while in a century the unequalled growth in the industrial and transport demands of our country has resulted in the exhaustion of hardly 1 per cent of its coal resources, in the 64 years since the Drake well was drilled

RIGHT and WRONG USE of NATURAL GAS

Bureau of Standards, Department of Commerce, Washington, D. C.



Adapted - Polyzonous Furnace - Waste of Gas

Good Service with Low Pressures

WHILE OUR LIQUID FUEL SUPPLY IS MORE LIMITED THAN COAL, NATURAL GAS IS MUCH LESS ABUNDANT AND SHOULD BE CONSERVED

This shows a practical demonstration of the Bureau of Standards in saving this fluid. See also Natural Gas Manual for the Home, Tech. Paper 325, Bureau of Mines, 1922. Price 10 cents. Sold by the Supt. of Documents, Washington, D. C.

apparently 40 per cent of the available oil has been brought to the surface and consumed; and the rate of America's development is still accelerating.‡ "Yet with all the optimism that can be justified I would urge a policy of saving as to petroleum that should be rigid in the extreme. If we are long to enjoy the benefits of the petroleum age, which we must frankly admit fits into the comfort-loving and the speed-loving side of the American nature, we must save the oil. We must save it before it leaves the well; keep it from being lost, keep it from being flooded out, driven away by water. * * * We must save the oil after it leaves the well, save it from draining off and sinking into the soil, save it from leaking away at pipe joints, save it from the wastes of imperfect storage!"

* J. M. Wadsworth's "Efficiency in the Use of Fuel Oil," October, 1918.

† Editorial in *Texas Star*, April, 1914.

‡ George Otis Smith in *Mining and Oil Bulletin*, Los Angeles, January, 1920.

§ Franklin K. Lane in "Conservation through Engineering," Bulletin 705, U. S. Geological Survey, 1920.

The late Secretary Lane's earnest appeal seemed well on the way to be answered favorably by the established operators until two years ago when a legion of interlopers began an orgy of wildcatting and over-production that in the end will benefit nobody and in the meantime has crippled the spirit of conservation. In no other branch of the American mineral industry is a policy of conservation so imperative as in petroleum, more treasured than gold! How, then, may the life of this golden liquid be prolonged for posterity? Space here permits mere mention of some practical steps that may be taken:

- (1) Reduce the number of unnecessary automobiles; (2) stop over-development—by pooling of interests, otherwise by legal restriction; (3) refuse to sell oil for utilization without refining it; (4) store oil underground through cooperation of producers, thus avoiding vast loss through leakage and evaporation; (5) develop substitutes for part of the gasoline used as motor fuel, the growing demands for which has set the galloping pace for crude oil production; (6) in order to fill prior demands for Diesel engines, naval vessels, and the merchant marine; develop hydro-electric power*, and failing that fall back on coal if it is available and not too costly, even in the oil fields themselves or wherever liquid fuel is lavishly burned for power purposes; (7) adopt priority rules to get higher utilization of petroleum, and in connection therewith favor the use of coal and its products wherever these will serve the same purpose; (8) increase the recovery of the natural resource by artificial methods already mentioned, and in abandoned shallow fields begin the mining of oil sands as soon as the prices of crude oil justify such a step; (9) discourage the cracking process wherever applied to crude oil having a lubricating component, for the increased gasoline recovery is gained at the expense of the latter, for which there is now no sufficient substitute; (10) educate the consumers not to waste any petroleum product that can be used over again, such as lubricating oil† even if it is temporarily contaminated or diluted; and (11) encourage our nationals in their discovery and development of foreign fields.

Monopolies. Since the dissolution of the Standard Oil trust in 1911, there cannot be said to exist any general or lateral monopoly in the American oil business such as is found in Dutch East India and other foreign regions.‡ The growth of the so-called independents, the oldest important ones of which began work with the Beaumont discovery by Captain Lucas in 1901, has been so rapid as to prevent any extensive or geographic control of crude oil production. What practical monopolies

*The best course for the power industry is the use of natural water-power sources, as far as practical, for the purpose of saving human energy, coal, oil and other resources. Electric power is an aid to the production of raw material, to transportation, manufacture and utilization of the products of industry. Frank G. Baum of San Francisco quoted in the *New York Tribune*, September, 1923. The building of the Glen Canyon dam at Lee's Ferry on the Colorado will result in the reduction in fuel oil consumption of about 90 million barrels yearly. *Scientific American*, April, 1922, page 247.

†Read "The Regeneration of Used Lubricating Oil," *Scientific American Monthly*, March, 1920, page 196.

‡It is apparent, from the vagaries of its price performances this year, especially in the crude oil section, that the industry lacks even the control essential to stabilization. How otherwise can one account for such events as the advancing of crude oil prices in the early days of 1923, when production was running wild; stocks were already of enormous proportions, and consumption was at its lowest ebb?—Editorial, *Oil, Paint & Drug Reporter*, May 28, 1923.

are known to exist are of two kinds: (1) Local or regional in regard to pipe-line transportation; and (2) natural or **vertical** in so far as one organization may control all the related economic functions of production, transportation, refining and distribution and thus permit its products to stay in its own hands all the way from the well to the market.*

The decline in control of the refining industry is evidenced in a brief submitted to the Federal Trade Commission by R. L. Welch, secretary of the American Petroleum Institute, who declared that the "Standard" group in 1911 refined 80 per cent of the gasoline produced in the United States; in 1915, 60 per cent; and in 1919, only 49 per cent. From the table below it appears that this group, at the close of May, 1923, was refining only 45 per cent and was producing only 25 per cent of the crude oil of the United States.

PARTICIPATION OF THE STANDARD OIL GROUP IN THE AMERICAN PETROLEUM INDUSTRY ABOUT THE MIDDLE OF 1923†

	Per Cent	Stocks at the close of May 31, 1923:	Per Cent
Crude oil produced.....	25	Crude oil, 164.7 million bbls.....	58.5
Crude oil refined.....	45	Gasoline, 648.3 million gals.....	75.7
Investments.....	40	Kerosene, 729.5 million gals.....	72.0
Domestic market.....	55	Gas & fuel oil, 736.6 million gals.....	55.7
Foreign market.....	75	Lubricants.....	?
Pipe line ownership.....	60		

As a result of the recent findings of the Senate oil investigation committee, eight recommendations were made to curb the alleged evils: (1) Establishing a uniform system of accounting * * * so that the reasonableness of prices for petroleum products can be found on a cost basis; (2) starting a compulsory system of reports to the government showing the operations of each oil company engaged in interstate commerce; (3) making pipe lines real "common carriers" through divorcing their ownership from the oil transported, etc.; (4) revising (railway?) freight rates on products so Mid-Continent refiners may again market their output through Michigan, Indiana, Ohio, Pennsylvania and the New England states; (5) prohibiting or regulating the exportation of petroleum and its products for which there is pressing demand in the United States; (6) starting grand jury proceedings wherever price manipulation is attempted; (7) investigating "implied" or expressed agreements to fix prices arbitrarily or to restrain trade, and, if warranted, citing parties to the agreement for contempt of court; and (8) inquiring into all claims for

* In a fundamental economic sense the petroleum industry is highly integrated—an activity expected from a purely physical standpoint to function with maximum efficiency as a natural monopoly. The tendency toward financial unity in keeping with the underlying economic structure was effectively shown during the earlier decades of the development culminating in a country-wide organization, the Standard Oil Co. of N. J.—Pogue's "Economics of P.," page 3.

† According to *The Financial World*, published by the Guenther Publishing Co., 53 Park Place, New York, N. Y., who early each year issue a very good review of the oil industry in pamphlet form for \$1.00.

In 1921 the Royal Dutch-Shell group had almost 33 per cent of the crude production in all countries other than the United States. This control included practically all the yield in Venezuela, Egypt, and British Borneo, 97 per cent in Dutch East India, 29 per cent in Rumania, and over 26 per cent in Mexico, while the proportion obtained in Trinidad was about 16 per cent.—"Foreign Ownership in the Petroleum Industry", U. S. Federal Trade Commission, Febr. 12, 1923, page 17.

basic patents on pressure still processes used in the production of gasoline.

According to the **Financial Review** of August 12, 1923, the particularly novel evidence brought forth by the La Follette examination was that refiners evidently think they are justified in shouldering all their expense upon gasoline production alone. The head of the American Petroleum Institute has put himself on record that refiners as a whole have operated at a loss since 1920.

Such disclosures are sharpening the public taste for mining rather than for oil shares. The **Standard Daily Trade Service** of March 12, 1923, says: It will be the wasting away of natural resources rather than "manipulation" that will slowly carry prices up to a point endangering the prosperity both of the petroleum and the automotive industries.

It must be admitted, despite minor disadvantages, that mergers and monopolies as a rule make for conservation and make it possible not only to reduce costs of production, refining and marketing, but also to stabilize prices even if these are not materially lowered at any one time. It is decidedly better for the ultimate consumer to pay a fair and fixed price for gasoline and other petroleum products than to be subjected to the uncertainties of sudden fluctuations. Abnormal price depressions, such as the one experienced in 1923, cannot but encourage continued waste of a fuel supply that is far more limited than even anthracite.

REVIEW OF TRAGIC '23

The Statistical Story. Two outstanding economic events were the gasoline war with its disastrous effects and the attainment of the peak or high point in production on the part of so many large pools within one calendar year. It is beyond belief that the true prosperity of the American oil industry will ever be threatened by the recurrence of two such related events. Practically all past achievements in petroleum were set aside in 1923. Following are the rounded figures for the more important records reached in the year just closed compared with those of 1922, itself a year of economic eclipses:

Point of Comparison	1922	1923	% Incr.
No. of fields surpassing 100,000 bbls. daily (peak)-----	1	8	700
Total number of active oil wells-----	285,000	300,000	5.3
Average daily yield per well, bbls.-----	5.3	6.7	25
Million Bbls.			
Average daily yield of all wells-----	1.5	2	31
Total production of all wells-----	557.5	735	31.
Total imports (nearly all Mexican crude) (decrease)---	127.3	80	(37)
Total new supply of all crude oil-----	684.8	810	18.3
Tank-farm and pipe-line stocks, January 1-----	191	265	38.7
Total old and new supplies for year-----	875.8	1,075	22.8
Exports (83 to 85 per cent refined oils)-----	68	94	38
Apparent consumption (after allowing for change in stocks,-----	592.4	708	19.5
Per capita consumption of crude-----	5.4	6.3	14

APPROXIMATE STATUS OF STOCKS IN THE UNITED STATES AS OF JANUARY 1, 1924.

Nature of Stock	Million Bbls.	Nature of Stock	Million Bbls.
Gasoline-----	23.3	Crude oil, all except on leases--	350
All refined oils-----	75 ?	Total of all oil-----	460 ?
Semi-refined oils-----	35 ?		

As shown in the following chapter, gasoline stocks attained the tremendous peak of 31,800,000 barrels on April 30, 1923. Production reached its peak or "top-notch" in July with a daily yield of 2,300,000 barrels. It is to be noted that these are maxima, not for 1923 alone, but for the entire life of the American petroleum industry. The most popular change was the drop in prices;* in regard to gasoline probably 30 to 35 per cent on the average and fully 50 per cent in extreme cases where the gasoline "war" was carried on. On the other hand, costs to a majority of the producers must have climbed, although they fell in a few places where the average daily yield per well ran into hundreds of barrels, as at Long Beach and Santa Fe Springs near Los Angeles. But even here the costs went up as the wells went down; and now, as fast as the newer and deeper wells cease to flow and are put on the pump, the lifting charges will take a jump. Data on well depths are not complete, but it may be safely said that the weighted average depth of production in the United States is now not less than 3,000 feet compared with an estimated average of 2,800 feet for 1922.†

A Tragic Time in Oildom. To the ultimate consumers of petroleum products, motorists in particular, the major part of 1923 apparently teemed with treasure, for at one time they were able to get gasoline for as little as 6 or 7 cents a gallon in Los Angeles. Also, to these and others outside of the producing industry who observed the feverish drilling, the increasing output, the stampede to build storage and to rush the oil away from the flowing wells by pipe line, rail and sail, the industry may have seemed supremely prosperous. But to many inexperienced interlopers, to the great majority of established producers, and to some refiners and marketers, the year will long be remembered as truly tragic in a financial way because of price-cutting, high cost of storage construction, clogging of transport lines on land, etc. Tragedies, furthermore, took form in fires and explosions causing loss of life and liquid, in local ruination of underground resources, and in waste of labor and capital through wrong wild catting.‡

Lessons To Be Learned. Since it applies with equal force today, a summary published over three years ago by H. G. James in *The Oil and Gas Journal* is reproduced here for the information of sincere American citizens.

"If the agitation of the past months results in teaching the gasoline consumer economy, stops him in his mad career of money spending in joy rides, etc.; if it points the refiner his way to greater conservation of the

* The "Commerce Yearbook" of the United States Department of Commerce (60 cents. Supt. of Documents), gives average prices of crude and refined petroleum from 1913 to April, 1923, in connection with an 18-page review of the oil industry in 1922.

† The record for extreme depth of a single producer is held by the General Petroleum Co.'s Clock No. 1, at Long Beach, 5,959 feet, finished in 1923. About 10 miles away, in the Torrance-Redondo field, a world record for rapid drilling was made late in November. In the Black Diamond No. 1 well, 662 feet of hole were made and 560 feet of 15½-inch casing were set during 16 hours working time, according to *The Oil and Gas Journal*, December 6, 1923. The great geographic changes in the oil industry will be taken up in Chapter VIII; the financial events in Chapter XII.

‡ "Oil Industry Sick, in Danger of Price Rise," *Washington Herald*, Nov. 27, 1923, in which E. J. Clapp quotes Pres. W. S. Farish of the Humble Oil Co.: "Marking up the price too soon would set the wildcatters loose again in areas where we know there is oil and production would swamp us again."

Several factors contributed to the finding and rapid developing to maximum yield of so many large pools during the past thirty months resulting in unprecedented over-

raw materials with which he has to work, and prompts him to find ways and means of lengthening out the supply, through more efficient distillation and smaller losses one way and another; if it forces the automobile manufacturer to study more carefully the principle of carburation; if it brings greater degree of sanity among the people; if it stirs the Government to a more practical and patriotic defense of a great industry; if it brings cohesion among petroleum organizations; if it results in a *cessation of unreliable and unintelligent information concerning the industry to the public*; if it secures the merging of the various departments and bureaus handling oil matters at Washington into one comprehensive and well directed board, then shall we have cause to congratulate ourselves over what has been done.

"One thing more than anything else is needed * * * and that is not only complete statistics, but a comprehensive interpretation of the same. One of the difficulties today is not so much the meagerness of oil statistics sent out from Washington as the unfortunate interpretation of the same. But there is no cause for discouragement or fear. The oil industry is progressing and, broadly viewed, is in better condition today than it has ever been before. It must be borne in mind that from Drake to this day it has been peculiar of oil that it has always been on the verge of disaster from either over-production or over-consumption, yet its course has always been forward to bigger and better things."

production: (1) Wider application of geology, (2) use of (diamond) core drills, (3) deeper and faster drilling with rotaries, (4) improvements in tools and equipment, (5) employment of production engineers, and (6) use of trucks and even tractors.

An Associated Press dispatch in the *Washington Star*, December 31, 1923, quotes W. C. Teagle, president of the Standard, of New Jersey, to the effect that no other industry holds quite the uncertainty that the oil business does, since no one can foretell for any long period ahead the course of petroleum production. "Throughout 1923 the volume of business has been good, but much of it at prices that allowed no profit to the producer, refiner or marketer, unless the latter happened to be a jobber with no liabilities either as a producer of crude or as a refiner * * * With further gains in consumption (following the late drop in production) it looks right now as though the country should begin consuming more petroleum than it produces around the middle of 1924."

A recent estimate appearing in the *Wall Street Journal* places the total *retail* value of petroleum products, inclusive of the crude directly consumed, at \$5,000,000,000 compared with a *wholesale* value of farm crops of \$8,323,000,000 for the year 1923. The retail value of farm products was likely not less than \$15,000,000,000.

The past year proved tragical, as usual, to many victims of oil-stock frauds; but it also developed a Nemesis in Postmaster General New and another in Attorney General Daugherty, who, cooperating with Texas authorities and the National Vigilance Committee of the Associated Advertising Clubs of the World have terminated the activities of certain "worth" less swindlers and thus partly removed unjust reflections on a respectable though leaderless industry (see Chapter XIII, in part two).

CHAPTER VII. GASOLINE AND THE AUTOMOTIVE INDUSTRY

These two subjects are treated together in one chapter because (1) the existence of a suitable fuel was the great incentive to the application of internal combustion engines to the moving of horseless vehicles, and (2) nearly 90 per cent of the gasoline produced is at present consumed by autos, trucks and tractors.

GASOLINE OR MOTOR FUEL*

What Gasoline Is. It is not a single hydrocarbon (i. e., a compound of the elements carbon and hydrogen), but a mixture of very many different hydrocarbons, some of similar and some of different boiling points; therefore, gasoline will not boil at one temperature but within a long range of temperatures. Thus a commercial gasoline which meets the Bureau of Mines specifications, will begin to boil at about 140° F., while the heaviest parts of it will not boil much below 437° F. The main point is that a good commercial gasoline should have a uniform range of boiling points from the lowest to the highest, and *this and not the gravity should be the criterion of quality.*† In the early days of refining, when kerosene was the chief product and was priced higher than gasoline, the distilling operations were so regulated that the "naphtha distillate," now practically all used for the manufacture of gasoline, was then included in the kerosene fraction with respect to the higher boiling fractions of what is now called gasoline.

Three Sources of Gasoline. The big bulk of this light liquid comes from refineries using the so-called straight run process. Probably 85 per cent of all the 147.6 million barrels of refinery gasoline produced in 1922 was obtained in this way, the cracking processes having been the source of the rest. According to Messrs. Dean and Jacobs‡, cracking has now become a factor of decided commercial importance, the daily production from Burton stills having been about 2 million gallons during 1921. The processes of cracking to increase the yield of gasoline came into use in the course of a decade as a result of the extraordinary demand for motor fuel; but their use entails a sacrifice of other products. In 55 Mid-Continent independent refining plants there are no less than 20 different types of the process in use besides the many more on the market.¶

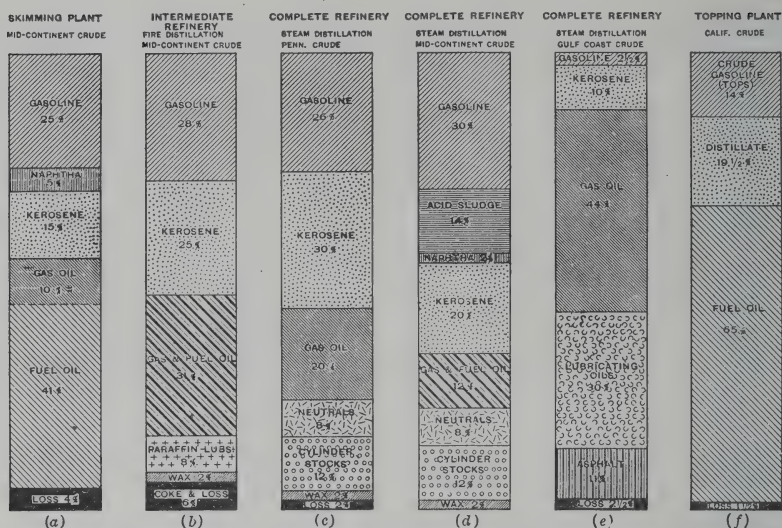
* The term "Gasoline" is used rather loosely in the commercial world. In England it is called petrol, in Germany benzin, elsewhere in Europe essence, and in some British colonies motor spirits.

† In the early days the gravity range was only 6°, from 66° to 72° Baumé (Page 175, "Mexican Petroleum" by W. J. Archer); now the range is nearly 20° if not greater. See page 77, "The Texas Company, Its Facilities and Products," by The Texas Co., 17 Battery Place, New York.

‡ Bureau of Mines' Technical paper 258, Production of gasoline by cracking heavier oils," 1921.

¶ *The Lamp*, May, 1923.

The *Oil Trade Journal*, Sept., 1922, describes the McAfee process of the Gulf Refining Co. which employs aluminum chloride as a catalyzer at temperatures of 500° to 600° for converting high boiling petroleums into gasoline, etc., with a recovery of 80 to 85 per cent.



CRUDE OILS YIELD UNEQUAL QUANTITIES OF GASOLINE

That is why a ratio between the price of gasoline and the price of crude cannot be fixed.

This chart also shows that the lubricant element is lost if present in crude oil run through skimming and topping plants; and why Pennsylvania crude commands the highest price. (Reprinted from Pogue's "Economics of Petroleum," by permission of John Wiley and Sons, Inc.)



—The Bessemer Gas Engine Co., Grove City, Pa.

PLANT FOR RECOVERING GASOLINE FROM CASING-HEAD GAS

Located at Lambertson, Ark., and owned by Koppers Co., a Mellon subsidiary; daily capacity, 7,500 gals. raw gasoline. Note the derrick over the well, the absorption tower nearby, and the condenser at the extreme left. Unlike oil refineries, plants for recovering gasoline from natural gas are placed not far from the oil and gas wells that supply the fluid.

Natural gas, or so-called casing-head gas of oil wells, is the third source of gasoline. The liquid, formerly lost, is recovered very largely in two ways: (1) By compression (and cooling) of very "wet" or rich gas, this being the first method used; and (2) by absorption with the help of oils cut usually between heavy kerosene and light lubricating oil, although by enriching naphtha as the absorbent the latter may be marketed directly as gasoline. It pays to use the second method even if the yield of gasoline is as low as 0.2 gallons per 1,000 cu. ft.; but not the first, at least in the Mid-Continent field, if the yield is less than 1 to 1½ gallons. Some gas there contains as much as 23 gallons per 1,000 cu. ft.* Since 1910 the casing-head gasoline industry has added materially to the supply of motor fuel. In 1911 the 176 plants produced only 277,000 bbls.; in 1921 the 1,056 plants produced about 10,700,000 bbls. from 480,000,000 M cubic feet of gas. The estimated yield in 1922 was 506,000,000 gallons or about 12,000,000 bbls. worth \$72,700,000. There are seven times as many compression as absorption plants, but they produce hardly one-fourth as much gasoline as the latter. This conservation (i. e., utilization) of a natural resource once wantonly wasted now doubly helps the motoring public: (1) By blending natural gasoline with the refinery product, in quantities up to 15 per cent, an *increased extraction* of "straight-run" gasoline is made possible (through raising the end-point, that is, distilling with it some of the heavier liquids, or fractions having higher boiling points, such as part of the old-time kerosene); and (2) by making a much *better product* from a standpoint of motor efficiency whether in regard to power, mileage, volatility or carbon.†

REMARKABLE GROWTH OF THE GASOLINE INDUSTRY.

Production. The following table shows the rapid increase in output and in exports expressed in *millions of barrels* of 42 gallons each:

Year	Yield	Exports	Year	Yield	Exports
1904 -----	6.3	0.6	1919 -----	94.2	9.0
1909 -----	12.3	1.6	1920 -----	115.8	15.0
1914 -----	34.9	5.0	1921 -----	122.7	12.7
1915 -----	41.6	6.5	1922 -----	147.6	13.7

The yield of gasoline during 1923 approximates 180 million barrels. The exports are proceeding at a rate of about 9 per cent of the yield.

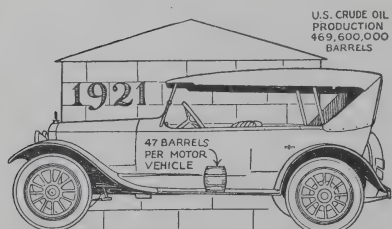
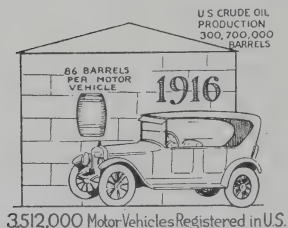
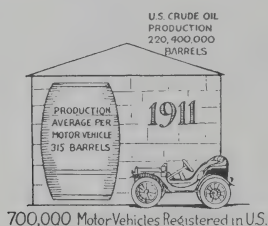
This tremendous growth, about 2,200 per cent in 18 years, 1904-22, has been attained: (1) By discovering new pools; (2) by introducing the casing-head gasoline industry, (3) by applying the cracking processes and im-

* Extraction of Gasoline from Gas, Chap. XIX, "The Business of Oil Production," Johnson-Huntley-Somers, pub. 1922 by John Wiley & Sons, Inc., New York. Leslie, in "Motor Fuels" says it pays to use the absorption process if the gasoline yield is 0.1 to 1.0 gallon per 1,000 cu. ft. In (3) the adsorption process, solids are used, such as charcoal and Silica-gel molecularly and not mechanically to take up the gasoline temporarily. According to F. P. Peterson,** who has been identified with the business since its inception, commercial development started near Kinzua, Pa., where a small plant was built by John L. Gray in the years 1907-1910, closely followed by work at Sisterville, W. Va., and Bolivar, N. Y.

†The Association of Natural Gasoline Manufacturers is prepared to prove that the economic value of straight-run gasoline is enhanced by this operation of adding natural gasoline to the refinery product.—D. E. Buchanan on "Handling of Natural Gasoline," read at the New Orleans convention of the Western Petroleum Refiners Assn., 3-9-1922, according to *The Oil Weekly*, April 15, 1922. See also "Casinghead Gasoline Manufacture" by L. E. Barrows, *The Teraco Star*, Nov., 1922, and "Gasoline from Natural Gas" by H. C. Hooper, *The Lamp*, April, 1920.

proving other refinery methods, and (4) by producing gasoline of higher end point.*

Consumption and Stocks. Harmonizing with the great growth in the number of registered motor vehicles, the total consumption of gasoline has annually increased more rapidly than both the production and consumption of crude oil. Although the crude output has steadily gained it has not kept pace with the vast advance made in the number of operated vehicles; and so the number of barrels per car has fallen off as indicated in the illustration herewith. During the 8 years, 1915-1923, yield of crude gained 166 per cent, while the motor cars increased 470 per cent. The only way the fuel supply has been maintained has been by getting more and more gasoline out of a given quantity of crude. As shown above, the number of barrels of crude oil produced per vehicle has dropped from 119 in 1915 to 45 in 1922, rising for the time being to 53 in 1923.



TEN-YEAR GROWTH OF TWO GIANT INDUSTRIES (From Mining and Oil Bulletin)

INCREASE IN RECOVERY FROM CRUDE.

Year	Yield in Million Bbls. Total Crude	Gasoline	Per Cent from Crude*
1909	183.2	12.9	9.3
1914	265.8	34.9	17.5
1915	281.1	41.6	18.3
1917	335.3	67.9	21.6
1919	378.4	94.2	26.1
1921	472.2	122.7	27.7
1923	735 (?)	180 (?)	29.4

* Per cent of crude oil run through the stills; not per cent of the total yield.

PRODUCTION AND CONSUMPTION PER MOTOR VEHICLE

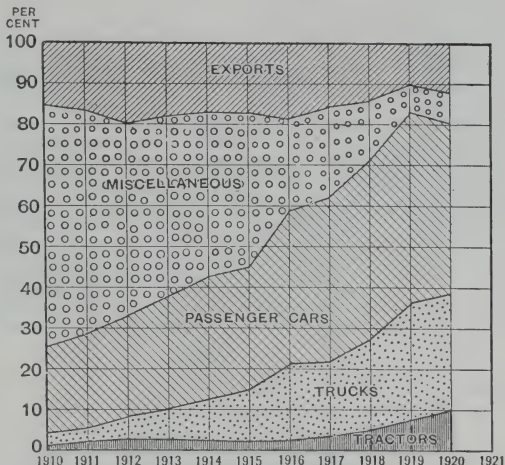
Year	Million Vehicles**	Barrels per Vehicle Crude	Gasoline
1915	2.4	119	14.3
1916	3.5	86	11.5
1917	5.1	66	11.7
1918	6.2	58	12.1
1919	7.5	50	11.9
1920	9.2	48	11.4
1921	10.5	45	10.4
1922	12.2	45	10.5
1923	14.	53	11.5

** The tabulated statistics of registered motor vehicles and production of crude oil per car for 1921 are later than those which are shown in the figure to the left. Hitherto, future production of motor vehicles has generally been underestimated by the best of authorities from year to year; and the domestic saturation point may be reached by 1930, or sooner if motor highways are rapidly extended.

About 300,000 trucks were owned on farms in 1922. In 1922 30 per cent of all the motor cars belonged there. On Jan. 1, 1924, there were about 4,250,000 cars of all kinds owned by farmers in the United States—or $\frac{1}{4}$ of the world's motor vehicles.

* "Growth of the Gasoline Industry," W. C. Mundt, chief engr., The Teas Pipe Line Co. of Okla., in *The Texas Star*, March, 1922. The figure on page 124 shows the rising end point. Semi-annual motor gasoline surveys of the Bureau of Mines show a tendency toward uniformity in straight run gasoline in so far as the range in end points has diminished from 115° F. in 1917 to 54° F. in January, 1923.

On the other hand, the consumption of gasoline per motor vehicle has fluctuated very little the last 8 years, as seen in the preceding table. From 1914 to 1923, inclusive, the tractors, trucks and passenger cars consumed altogether 80 per cent of the 820 million barrels used in the United States beginning with 26 per cent in 1910 and increasing to 43 per cent in 1914, according to the accompanying chart. Of all the gasoline now used, 90 per cent propels motor vehicles. While the average annual consumption per car during the past 9 years was 380 gallons, the annual rate during 1923 and at its close was about 500 gallons. There exists



PERCENTAGE ANALYSIS OF THE DEMAND
FOR GASOLINE, 1910-1920*

not only a time variation, but also a geographic range in the demand for motor fuel. On account of the climate, the annual consumption per car is considerably greater in Florida and California than, for instance, in Minnesota and Montana, where the winter weather interferes with motoring. (See chapter VIII.) In most of the northern states there occurs a seasonal change, the rate of demand dropping with the fall in temperature (or fall of snow) and with the rise in quality of the gasoline. Furthermore, trucks, take more fuel than pleasure cars. A few years ago, according to Pogue, the annual consumption factors were as follows: For passenger cars, 300 gals.; light trucks, 1,000 gals.; and heavy trucks and tractors, 2,000 gals.

In 1923 our total demand for motor fuel exclusive of kerosene approximated 4 times that in 1916, only seven years before, as set forth in the following table:

RECENT INCREASE IN CONSUMPTION AND STOCKS OF GASOLINE

(Millions of Barrels)

Year	Indicated Consumption	Stocks Dec. 31	Days Supply	Year	Indicated Consumption	Stocks Dec. 31	Days Supply
1914	29.9	6.7	80	1919	82.0	14.0	44
1915	34.9	4.9	50	1920	101.5	11.0	34
1916	40.6	?	?	1921	108.0	10.6	49
1917	58.4	9.8	57	1922	127.0	21.4	57
1918	74.8	7.1	36	1923	160(?)	23.3	48

In calculating the number of days' supply, allowance has been made for the export demand, in which there was a decided drop in 1919, thus leaving 49 days' surplus for home consumption at the end of that year.

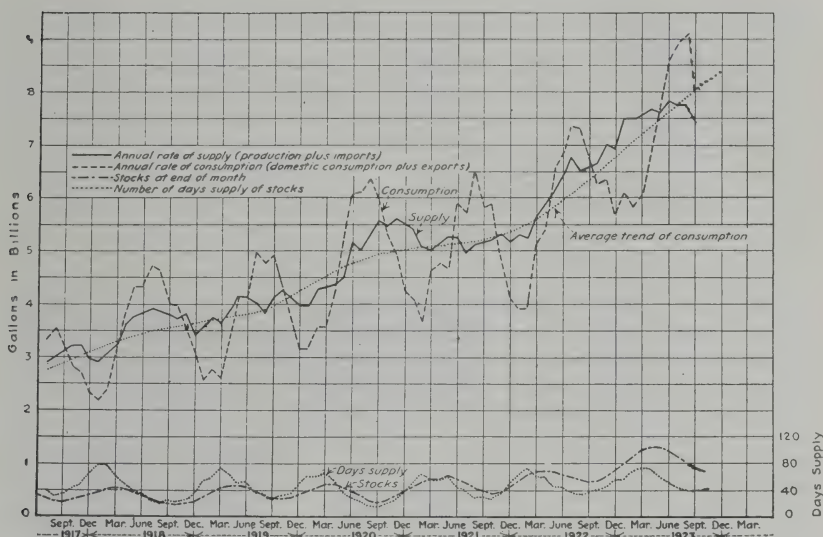
*From Pogue's "Economics of Petroleum," p. 127; reproduced by permission of the author and the publisher, John Wiley & Sons, Inc.



—Mining and Oil Bulletin, Los Angeles.

"CARRYING COAL TO NEWCASTLE," MIDDLE OF 1920

The first of 7 train loads of gasoline from Texas to reach Los Angeles for relieving the sharp shortage over three years ago. In this train were 25 tank cars of 8,080 gallons or 192 barrels each. At 27 cents a gallon each carload was worth over \$2,180. Mayor M. P. Snyder is seen greeting E. W. Clarke, general manager of the Union Oil Co., of Calif.



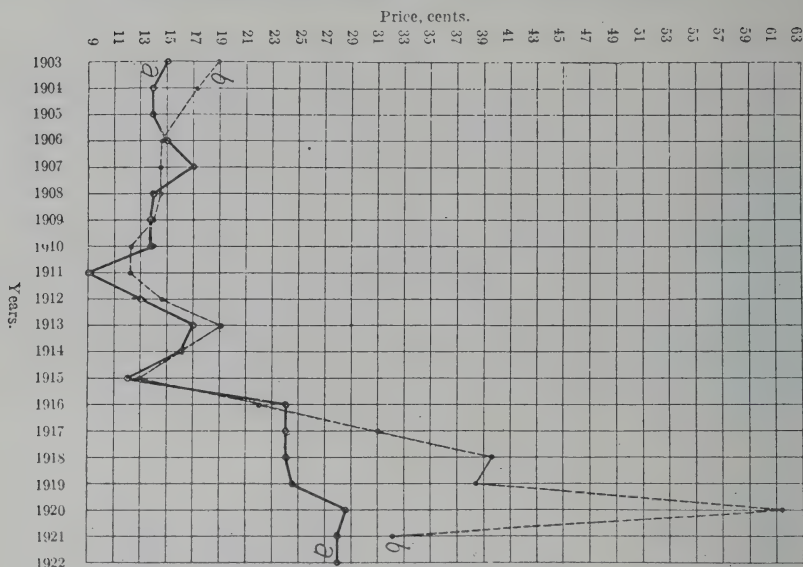
GRAPHIC REPRESENTATION OF THE SEASONAL CHANGES IN CONSUMPTION AND STOCKS, THE TREND IN SUPPLY AND CONSUMPTION, AND THE NUMBER OF DAYS SUPPLY OF GASOLINE, FOR SEVEN YEARS

Note that, as demand drops toward midwinter the stocks and the number of days supply rise. The "Kinks" in the graph of supply (production plus imports) are largely due to the impulse in production arising from the flush yield of new fields whose crude oils contain noticeable percentages of gasoline.

Stocks of gasoline increased about fivefold during the past 8 years; and despite the quadrupling of the output in that time there does not appear any improvement in the number of days' supply on hand—50 at the end of 1915 and about 48 at the end of 1923 (allowing for a seasonal drop in demand after Oct. 31). Compared with gasoline in the matter of stocks on Oct. 31, 1923, crude oil shows up to better advantage; 350,000,000 bbls. of crude oil, equivalent to 168 days' supply, and only 22,500,000 bbls. gasoline, or 47.5 days' supply. Supplies of gasoline stored above ground were the greatest in the history of the United States at the end of April, 1923. They amounted then to the enormous quantity of 1,336.4 million gallons, or 31.8 million barrels; and compared with the maximum monthly yield of 659 million gallons, or 15.7 million barrels attained in October, 1923. (The illustration herewith, from *Mining and Metallurgy*, shows the attainment of peak in both stocks and consumption of gasoline during the year 1923.)

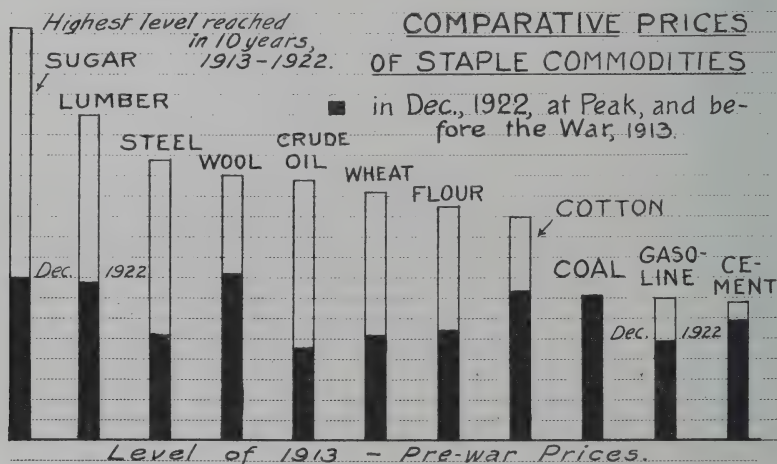
PRICES AND MARKETING OF MOTOR FUEL

Marketing Gasoline. So little kerosene has so far been used in the United States for propelling vehicles, that its marketing problems will not be taken up here. Public interest is focused on the prices and marketing of gasoline. The wholesale price of gasoline at Oklahoma refineries in October, 1923, has already been given in comparison with the prices of other products, in Chapter VI. The two illustrations herewith set forth



PRICE CHANGES ARE MORE GRADUAL IN GASOLINE THAN IN CRUDE

a, wholesale price per gallon of gasoline in New York City; b, average price of one-fifth barrel of crude oil. (Bureau of Mines, Motor Gasoline Survey of 1920 and 1921, page 6.) A part of the advance in the price during the latter part of 1915 resulted from increasing demand for motor fuel and decreasing production of light crude oil, particularly from the great cushioning pool (page 16, "Report on the Price of Gasoline in 1915," Federal Trade Commission, 1917). Over-consumption in 1919 culminated in the shortage of 1920, felt mainly in California, accounted for the 4-cent increase four years ago. (For average wholesale prices of gasoline, 1913 to 1921, see page 164, Bulletin 320 of the U. S. Bureau of Labor Statistics.) Late in April, 1923, the tank wagon price of New York City had dropped to 22.5 cents; and on July 23, 1923, it fell further, to 20.5 cents compared with 23 cents retail. In early December, 1923, the general average wholesale price in the United States was not over 14.5 cents.



GASOLINE NOW IS CHEAPER THAN IN DECEMBER, 1922, WHEN IT WAS LOWER PRICED THAN ALL THE OTHER COMMODITIES HERE CONSIDERED, EXCEPTING CRUDE OIL

Coal was at peak price and cement nearly at peak in December, 1922, when gasoline was only 25 per cent above its pre-war price in 1913. All the staples above represented, excepting cement, reached higher peak prices than gasoline during the 10-year period, 1913-1922.

three essential facts for popular consideration: (1) Gasoline has not fluctuated in price as far or as fast as the raw material from which it is extracted; (2) compared with the pre-war prices of 1913, the price of gasoline in December, 1922, had not risen as much as the prices of most other common commodities; and (3) the peak price of gasoline during the past ten years was relatively lower than that of all but two of the other ten articles represented.

This greater stability in the price structure of gasoline compared with that of crude oil, is supported by the greater concentration of marketing agencies in the hands of the Standard Oil group and a few large inde-



—Among Ourselves, June, 1923.

CIVIC PRIDE IMPELS GASOLINE DISTRIBUTORS TO BEAUTIFY THEIR SERVICE STATIONS

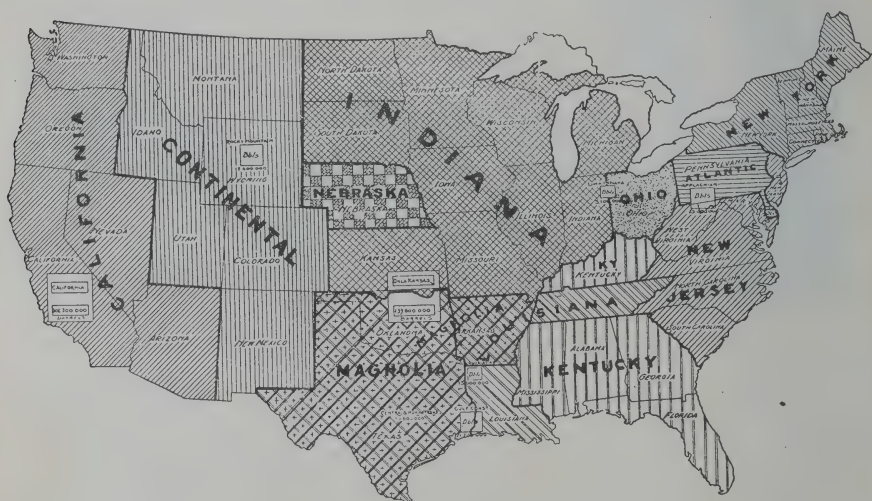
The various Standard companies handle almost half of the world's gasoline and lead in erecting ornamental stations in the United States. The latter often replace ugly structures, even corner saloons where another and diluted kind of liquid fuel was once wasted. In this view, taken at Alameda, is seen a eucalyptus tree, one of the first planted in California by the late Bishop Taylor who introduced, from Australia, this myrtaceous genus of evergreen which is said to grow 400 feet tall. On January 1, 1924, the total investment in American marketing facilities must have exceeded \$800,000,000.

pendents. Fortunately, such concentration has not been badly abused although the Federal Trade Commission reported, June 1, 1920, that "price initiative today seems to be left generally to the Standard companies and competition is apparently directed more to developing facilities for getting business than to seeking it by underselling." In regard to economy and efficiency the distribution of gasoline stands almost without a rival in the entire commercial field. It is because of its volatile nature and the widespread demand for it that the facilities for marketing gasoline have been perfected more than those for handling the other refinery products (see Chapter VI). Differences exist in the marketing practice in various parts of the country despite the fact that the Standard Oil group refines fully 45 per cent and sells 65 per cent of the gasoline.

Economically, the marketing of gasoline has become a rather simple

problem since the auto craze began to spread, and this product no longer remained a "white elephant" or "soup-bone surplus" on the hands of the refiner. However, with the development of the casing-head gasoline industry three special methods have arisen for disposing of this very volatile product: (1) Selling to a refinery for blending with low-grade gasoline in order to make a commercial grade of motor fuel; (2) buying the low-grade naphtha for blending at the natural-gas gasoline plant, which then markets its own gasoline, and (3) selling the product without blending for special purposes. There is a small but growing market for the light absorption gasoline in the chemical industries as well as for aeroplane fuel.

American Prices of Motor Fuel. These have never been high considering the prices paid by the consumers in foreign lands; nor have they been high recently compared with the pre-war prices of 1913. Throughout the 11-state territory of the Standard of Indiana and in line with the rising cost of crude oil, the price of gasoline was advanced 2 cents on December 29, 1923. In Chicago the prices then became 14 cents from tank wagons and 16 cents at filling stations; and on Jan. 13, 1924, they rose respectively to 16 and 18 cents. (See *Oil Trade J'n'l.*, Jan., 1924.)



GASOLINE MARKETING TERRITORIES OF THE STANDARD COMPANIES

Map from the Federal Trade Commission's report dated April 11, 1917; reproduced in Pogue's "Economics of Petroleum."

The price "war" of the past year was clearly not a wise affair, for it did not permanently benefit the consumer but instead drove some independent dealers out of business. However, through cooperative buying, the farmers of South Dakota and other states should be able to get gasoline as well as kerosene so reasonable that they will again turn to tractors for reducing their operating costs.* Of greater economic importance than the seemingly high prices prevailing from 1916 to the middle of 1923, is the

* While in the Red River valley, in the fall of 1923, the author learned that many wheat growers of Minnesota and North Dakota had discarded their tractors when gasoline went above 22 cents or kerosene above 15 cents.

enormous waste of this popular liquid—95 per cent of the efficiency* and at least 30 per cent of the substance itself. For obvious reasons, one being this continued waste of motor fuel, further price increases may be expected during the year 1924.

Few consumers realize that in 1923 there were places in the United States where distilled water sold for more than gasoline, itself a product of distillation. How many motorists, complaining at a price of 25 cents to 30 cents a gallon for gasoline consider that they pay for coca-cola at the rate of over 40 cents a gallon when they indulge in the diluted drink at 5 cents a glass?

Most important for motorists to know, in this connection, is that of the total of \$7,783,000,000 spent on motor cars in 1921,† inclusive of their operation, *less than 11 per cent was for gasoline*; yet this item caused more agitation and animosity than all the other items that made up this huge expenditure.

A Defense of Fair Prices and a Badly Abused Industry. According to *The Oil Weekly* of November 3, 1923, the Mid-Continent Oil and Gas Association has carried on a publicity campaign to forestall unfair legislation and to stem the tide of adverse public opinion. Following are the author's abstracts of corrected statements published by this independent organization. They are worthy of serious consideration by all fair-minded Americans, members of law-making bodies in particular.

Alleged manipulations of prices and rumors of "dollar gasoline" greatly concern you, as motorists. You may have asked, what truth is there in it? Ask yourself, "If gasoline cost a dollar a gallon, how much will I use?" Such a prohibitive price would lessen motoring among 14,000,000 American families so severely that very little market for gasoline would remain. Huge refineries would be idle, and the petroleum industry would lose the business for which it has labored full 50 years.

Since gasoline is the product of a competitive industry, raising its price unreasonably would prove impossible. There are about 15,000 separate and independent producers of crude oil, nearly 500 separate refiners producing gasoline, and 4,000 separate wholesalers or marketing companies. Competition is keen; and as the price of gasoline goes up, output is increased until demand is overtaken and the price falls again.

The average refining company makes less than one cent per gallon on gasoline. This is less than \$3.00 on an average annual run of 5,000 miles per car. Compare this with the profit on any other commodity known to you. You and your fellow motorists pay this profit of a nickel on a 5-gallon purchase—for what? For competing in the oil fields with 499 other refiners obtaining crude oil needed. (For paying interest on refinery investments exceeding 2 billion dollars.) For spending \$100,000,000 yearly in repairs and new equipment, maintaining an organization of almost 70,000 employees, and devising scientific ways and means for economically extracting the most good gasoline from each barrel of crude oil. For finding a market for the products less in demand so as to keep down the price of gasoline. For carrying ample stocks of gasoline to meet emergencies and seasonal changes. For maintaining a wholesale distributing system to insure the delivery of gasoline conveniently (and often at all hours). For all this service they receive a profit of hardly a cent a gallon. Is it too much?

At no time during or after the war did the price of gasoline sky rocket. When you were paying two and three times what you had been accustomed to pay for food, clothing, rent, and building materials, gasoline for your motor cost little more than before the war. Even crude petroleum, the source of gasoline, rose much higher than gasoline (see figure on an adjacent page). Why has the price of gasoline been held down? Because the companies have been carefully and efficiently managed under private ownership. They are not hampered (as in other countries where gasoline is costly) by expensive government regulations, but have been left free to serve the public with initiative, energy and economy. Gasoline is cheap today. Governmental interference could result only in overburdening the industry and increasing the cost of all petroleum products to you, the consuming public.

† B. F. Kettering, General Motors Research Corporation, addressing the American Petroleum Institute, St. Louis, December, 1923.

During periods of gasoline shortage, the joy riders rarely reduce their demands for the benefit of food producers who utilize trucks and tractors.

* According to Dr. Edwin G. Slosson, Director of Science Service, 1115 Connecticut Ave., Washington, D. C.



WHITE TRUCK WORKING OUT OF BAJEN, COLUMBIA

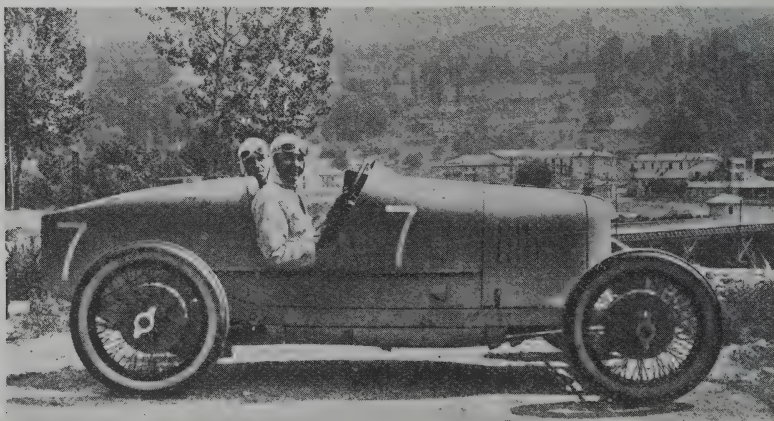
American trucks, like American drills, are fast invading foreign oil fields. Our exports of motor trucks increased 53%, from 7,480 in 1921 to 11,455, in 1922—443 to South America and 983 to Mexico; but in 1921, with the Mexican oil industry at peak, 1922, 10.5 per cent were trucks; but of 4,014,000 made in 1923 only 9.2 per cent were trucks.



MOTORIZING THE
WORLD'S FISHING
FLEET

This type of craft, brought from sunny Italy to San Francisco Bay, no longer depends on sail alone for motive power. (Standard Oil Bulletin.)

Norway's fishermen now consume 100,000 bbls. of distillates every year, being supplied largely by A. S. Norsk Braendselsolje, an Anglo-Persian subsidiary.



THE FAMOUS FIAT CAR WHICH WON THE ITALIAN GRAND PRIX

The driver was Pietro Bordino, shown here at the wheel. The Fiat is the best known European car in the United States. (*The Lamp*, Oct., 1923.)

ALCOHOL, BENZOL AND OTHER SUBSTITUTES

Substitutes Eventually Essential. With few exceptions the varying supply of gasoline has hitherto sufficed for the steadily increasing demand. But because of the higher prices abroad, as in France (see page 16), the advantages of using composite motor fuels have already been recognized. Eventually, American consumers must pass through this same stage, but it may be 50 to 75 years before gasoline will be almost entirely supplanted. This is a great problem with which our foresighted scientists are concerned, namely the source of our future supply of motor fuel. "How much will be needed and how much will it cost?" has been largely answered by E. H. Leslie in his new book entitled "Motor Fuels."* Eventually, when domestic and foreign deposits of petroleum shall have been depleted, perhaps in a hundred years, America will either have become motorless or will have developed satisfactory substitutes.

Alcohol as Motor Fuel is not of present importance in the United States. Ethyl alcohol is not fit for use in gasoline motors. Its vapor pressure is only one-fourth that of gasoline, and its latent heat of vaporization is 3.2 times that of gasoline, wherefore a gasoline engine is started with difficulty. This may be overcome by adding ether to the alcohol, by priming the cylinders, or by starting with a special fuel. Alcohol is also inferior in net heat of combustion, only 4-7 that of gasoline which is 19,000 British thermal units per pound. But it can be burned under pressure 2 to 3 times the maximum under which gasoline may be burned without knocking. It also burns without forming carbon and is safer to handle and move than gasoline. However, alcohol is handicapped for lack of distributive facilities. The maximum yield of alcohol, 202,000,000 gallons, was reached in 1917. Over 27 per cent of this was denatured, the rest taxable, and the total made but 1.8 per cent of the gasoline consumed in 1921. From all of the 13 kinds of materials hardly more than 500,000,000 gallons of alcohol can be produced, according to Leslie.*

Composite Fuels. Alcogas is a blend having a variable composition as follows, according to the U. S. Bureau of Standards:

Components of Alcogas	For Aviation	For Automobiles
Alcohol, per cent-----	40	33
Gasoline, " "-----	35	35
Benzol, " "-----	17	25
Ether, " "-----	8	7

Alcohol and gasoline do not mix completely, and hence a blending agent such as ether or an aromatic distillate must be used. Until gasoline goes above 35 cents a gallon there is no show for a large alcohol industry on which most composite fuels would have to depend in part. Natalite is fuel-blend of alcohol and ether made from molasses first in 1914 at Natal, South Africa. Another composite fuel listed by Leslie is Signal Core Mixture consisting of 20 per cent benzol and 80 per cent gasoline by volume. This is not specially superior to gasoline. "Hector" is 20 per cent benzol and 80 per cent cyclohexane, and has been patented by the

* "Motor Fuels, Their Production and Technology," The Chemical Catalog Co., 19 E. 24th St., New York, N. Y.; price, \$7.00. The U. S. Dept. of Agriculture has estimated that 300,000,000 gallons of ethyl or "grain" alcohol could be made yearly from saw-dust and other mill waste by special treatment.

General Motors Corporation. A mixture of kerosene and benzol called "Liberty" has been sponsored by the General Engineer Depot, U. S. A.

Miscellaneous. Naphthalene is a product obtained in the distillation of coal tar and is familiarly known as tar-camphor. Its high melting point alone prevents its use as motor fuel; but it may be dissolved in benzol or gasoline, and thus utilized to a limited extent, as in Germany. From it may be produced tetrahydronaphthalene, or "tetraline," by the addition of hydrogen. According to a British periodical,* tetraline gave good results when mixed with alcohol, benzol and gasoline. Dynalkol, as described in the U. S. Consular Report, is the commercial name given in Czecho-Slovakia to a fuel consisting of 40 per cent alcohol and 60 per cent benzol. Benzol probably ranks next to alcohol as a substitute for gasoline in quantity, but it does not compare in quality with tetraline. It yields more heat per gallon than gasoline but has sundry disadvantages if used alone. A table comparing benzol with gasoline has been made by the Kansas City Testing Laboratory.†



—Union Oil Bulletin.

OIL SHALE DEPOSITS IN WESTERN COLORADO

View at the Falls of Parachute Creek.

Shale-Oil as a Substitute. Even if all the coal mined in the United States were coked in by-product ovens, the quantity of motor fuel (benzol) produced thereby would amount to only 20 per cent of the annual domes-

* *The Pan-American Magazine*, 50 Great Russell St., London.

† *Waverly Petroleum Handbook*, 8th edition, page 583, W. Oil Works Co., 54th St., Pittsburgh.

Under "International Aspects of the Petroleum Industry," Van H. Manning wrote in *Mining and Metallurgy*, Feb., 1920: The products from the destructive distillation of coal can be used, in so far as they are available, to replace gasoline; but quantitatively it seems out of the question to expect more than a minor alleviation from them. Coal can largely replace fuel oils. Alcohol can replace gasoline and has the advantage that it can be made from replaceable material—that is, from plants, but because of its cost it cannot compete in a large way with gasoline at present. * * * Finally no substitutes are now known that will satisfactorily replace mineral lubricants in the amount needed. These facts indicate that we must inevitably seek foreign supplies in order to meet our own needs and compete in the world's markets. Increased recovery and wiser utilization of our domestic supplies will help solve the problem.

See also *Engineering and Mining Journal-Press*, June 10, 1922, and *The Literary Digest*, Aug. 5, 1922, page 27; Oct. 7, 1922, page 69; and Nov. 24, 1923, page 66.

tic consumption of gasoline. Scientists have therefore turned to our vast deposits of oil shales with a view of obtaining the future supply of motor fuel from this source. Few of the optimistic writers on this subject realize that crude shale-oil contains only a small per cent of low-boiling hydrocarbons, and that is of poor quality. Tremendous tonnages of the rock would have to be mined or quarried and large capital would be required for this purpose and for retorting the rock. The Bureau of Mines quotes estimates from 1 to 5 million dollars as the cost of a complete retorting plant to handle 1,000 tons of shale daily; and if the average Rocky Mountain shale yielded 42 gallons to the ton it would take at least 2,150 such plants operating 365 days a year to supply our domestic demand for crude oil at the annual rate prevailing in 1923.*

CONSERVATION OF MOTOR FUEL.†

The Society of Automotive Engineers is interested in the elimination of all forms of waste, including that of gasoline, the conservation of which is considered to be of particular importance. Gasoline has become a most important fuel because it has enabled us to place in the hands of almost everyone a prime mover in small units capable of reasonably satisfactory operation even by the most unintelligent. Due to the lack of technical skill of the great majority of the operators the tendency toward waste of fuel operation is greatly increased. Changes in design of automotive apparatus except in the direction of more automatically correct operation does not offer as fruitful a field for improvement so far as economy is concerned, as does *education of the user* along the lines of more intelligent operation of the vehicle.

Consumption. About 23 to 30 billion gallons of crude petroleum are used annually in this country in producing 5 to 7 billion gallons of gasoline, of which over 85 per cent is used by automotive vehicles for purposes of transportation. Of these vehicles, only a very small proportion are operated under centralized supervision to promote maximum economy of operation.

In the production and distribution of motor fuel from crude petroleum, and in the use of this fuel, there is bound to be some waste as there is in all other commercial activities. Part of this is preventable by means already at our disposal. Other forms of waste, where prevention is probably possible, are the subject of concentrated study at the present time. The losses which occur in the manufacture and distribution of gasoline are not directly within the province of the automotive industry, and we will therefore confine ourselves in this statement to the preventable waste in the actual use of fuel.

* "The Oil-Shale Industry With Respect to the Petroleum Situation," by J. R. Reeves, *Eng. and Min. Journal-Press*, April 21, 1923. Read "Billions of Barrels of Oil Locked up in Rocks," by Guy E. Mitchell, *National Geographic Magazine*, Feb., 1918; *Commerce Monthly*, Feb., 1922, published by the National Bank of Commerce, New York; articles by Victor C. Alderson in *Mining and Oil Bulletin*, Dec., 1919, Jan., 1920, and Mar.-Apr., 1921, and in *The Mining Congress Journal*, Oct., 1922, Jan., 1923, and July, 1923, "Shale Oil Experiments," Chas. E. Kern, *The Oil and Gas Jn'l*, Nov. 30, 1922; "The Oil-Shales of the U. S. and the Future of Petroleum," R. H. Tingley, *The Outlook*, Oct. 17, 1923, and Bulletin 210, by M. J. Gavin (U. S.), Bureau of Mines.

†At one time (before the Drake discovery) over 50 companies were distilling oil from coal and shales." Etienne A. Ritter, *Engineering and Mining Jn'l*, Feb. 17, 1923.

†Extracts from H. B. D. Exhibit No. 2, testimony before the Senate Committee investigating gasoline prices, made February 9, 1923, by H. B. Dickinson, Research Manager, for the Society of Automotive Engineers, which numbers 5000 members.

Efficiency. The quality of gasoline, which partly determines its cost and the economy with which it is used, evidently has a considerable bearing on the ability of the user to operate his vehicle with maximum efficiency. This feature of fuel production vitally concerns the automotive industry and has been the subject of research and development since 1912, under the auspices of the Society of Automotive Engineers and, further, of co-operative research under the joint direction of the engineers of the automotive industry and of the petroleum industry, as represented in the American Petroleum Institute.

Limited Supply. Gasoline for motor fuel has come to be the highest-priced quantity product of petroleum, except lubricating oil, and the motor vehicle is the largest single user of both products. Neither of them has any competitor at anything like the present prices, and petroleum, the source of both, exists only in limited quantities which may be exhausted in a comparatively short time. Hence the elimination of waste is as important for conservation as for the maintenance of a minimum fuel cost. Unfortunately, low cost and conservation do not always go together. In so far as the user is responsible for elimination of waste, a higher cost offers more incentive for economy.

Internal Combustion. Essentially, the automobile engine consists of a number of cylinders in which gasoline vapor, mixed with air, is burned to produce pressure which is transmitted to moving pistons and applied as power to the crank-shaft and thence to the wheels. The fuel must be vaporized and intimately mixed with air in the correct proportions at the time that ignition takes place in order to allow of efficient combustion.

Function of Carbureter. The carbureter and intake manifold are designed to mix the correct amount of fuel with the air, and to distribute the resulting mixture to the cylinders. The mixing of the fuel and the air begins in the carbureter and after continuing during the passage through the manifold is completed in the cylinder.

Pre-Heating Helps Complete Combustion. With the low-volatility gasoline now being supplied for motor fuel, a considerable amount of heat is necessary for the proper mixing of the air and fuel. This heating may be applied in different ways, either by maintaining the cylinders at a proper temperature, or by supplying heat to the carburetor or the manifold or both. If the correct proportion of fuel to air is not used, or if the mixture is not uniformly distributed to the different cylinders, some fuel will be wasted.

As a matter of fact, it begins to appear that the adoption of means for maintaining the engine at a uniform operating temperature under all climatic conditions will go a long way to improve economy. Experience indicates that this temperature should be fairly high to obtain the most efficient operating results. The economical use of fuel is thus promoted not only by the better utilization of the fuel itself, but also by maintaining the engine lubrication at maximum efficiency producing the lowest engine friction. It has been proved that temperatures provided by holding the cooling water at or near the boiling point are not too high. In addition, for use in cold climates, it may prove desirable to provide extra heat on the carbureter and manifold, especially at the time of starting, when the engine is cold.



AUTOMOTIVE, OIL AND AGRICULTURAL INDUSTRIES ARE INTERDEPENDENT

Modern farm operations rely on petroleum for power, light and lubrication; and in turn, many oil and gas wells are located on farm lands. Here is shown part of Peter Swenson's ranch which helped to make Stephens County once the leader of all Texas counties in oil. This farmer and his son are not only lessors and royalty owners; they have been producers since 1918 when they formed the Swensondale Oil Co.



PETROLEUM PERFORMS A DOUBLE DUTY

It drives the caterpillar tractor and also the dusting outfit. Itself may be used as an insecticide.



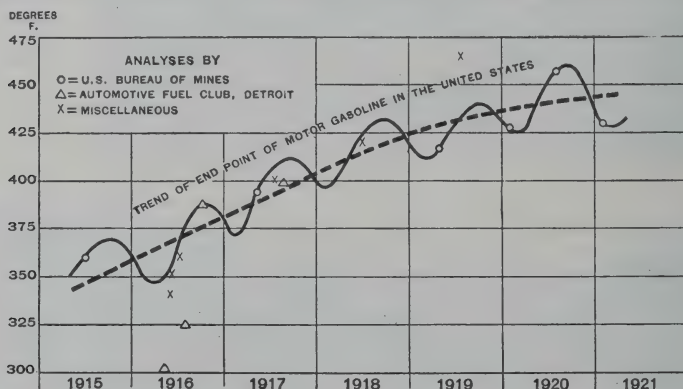
GOOD ROADS ENCOURAGE MOTORING AND HENCE THE PRODUCTION OF MOTOR VEHICLES AND MOTOR FUEL

This pictures part of the California State Highway near Descanso on a route from Imperial Valley to San Diego. California ranks first in yield of oil, extent of auto roads and per capita motor vehicles. This is a logical consequence of having vast resources in petroleum and ambitious, progressive citizens who know how to attract tourists and dwellers from other states.

Common Waste. A mixture may be twice too rich in fuel and still produce power, without any obvious bad effects to warn the operator that he is wasting fuel. Overrich mixtures are commonly used for reasons given below. Tests by the Bureau of Mines on 100 or more trucks and passenger cars picked out at random on a city street have shown that in average operation of trucks and passenger cars, 25 per cent of the fuel drawn into the engine passes out of the exhaust unburned.

Causes of Waste. The causes of waste of this kind are chargeable partly to the designer and partly to the user of the vehicle, or to the mechanic who attends to the adjustment. Practically all fuel systems require adjustment to give the correct fuel mixture. If these adjustments are not properly made, the waste of fuel may be 50 per cent, and probably the average loss in practice is at least 20 per cent. Owing to the large number of unintelligent and careless drivers who operate cars, it would be better if the carbureter setting and other adjustments could be made at the factory, but owing to variations in fuel and in weather conditions, this has not proved feasible up to date.

If the carbureter is so constructed that the correct mixture is not supplied under all driving conditions without continual hand adjustment, or if the mixture between the fuel and the air is not sufficiently complete at the time of ignition, there will be waste which no amount of care in adjustment can prevent. As to the question of a sufficiently intimate mixture, this involves the complete design of the power plant, including the carbureter, manifold, and engine, it being understood that the final



mixture is produced by means of a violent agitation with the addition of heat. There is little doubt that one-half the cars in use are deficient in design in the respects which make for proper mixture of fuel and air before ignition, and that the fuel consumption of these cars could be reduced at least 20 per cent by slight modifications in design and, in many cases, by simply replacing the parts which make up the fuel system by parts more efficient and already available.

Another direct source of fuel waste is the bad mechanical condition of many automobile and truck engines in service. Worn or improperly adjusted pistons and valves and ignition failures all waste fuel. Waste of this kind is partly a question of design and construction.

Raising Boiling Point Increased Supply. Commercial gasoline as sold to the consumer has become more and more difficult to use with economy.

Gasoline is a mixture of different constituents having different degrees of volatility or ease of vaporization. Up to about 1912 commercial gasoline contained only the most volatile constituents and offered no difficulty in vaporizing for producing a satisfactory mixture for use in the simplest type of engine. With the increasing demand it became necessary for the producer to include heavier and less volatile constituents, which require more heat for their vaporization, and as this process went on from 1912 to 1920, the utmost efforts of the designers were necessary to keep pace with the change in fuel and maintain reasonable economy.

We believe that the American automotive engineer is even now in advance of all others in the technique of economical fuel utilization. In dealing with the fuels of low volatility marketed in this country he has learned much as to the behavior of fuels in the engine and has profited by this knowledge in the design of efficient vehicles.

Mileage per Gallon. European cars average more miles to the gallon than American cars, but when reduced to a common basis of weight and reserve power the American cars are superior in economy. Due to high cost and taxation, European design has tended to attempt to secure high mileages by reduction of weight and reserve power. The demand of American car users, partly due to the poor condition of roads, has called for heavier weight and greater reserve power of average American cars.

Our best information indicates that a majority of 1-ton cars in the hands of average drivers actually cover not more than 16 miles per gallon of fuel. If these same cars were more carefully designed and provided with more satisfactory means for supplying the correct fuel mixtures, we are convinced that under the same operating conditions they would average 20 miles per gallon instead of 16, and that a further improvement of at least 25 per cent would be possible through more careful operation by drivers.

The fuel waste in commercial vehicles seems to be even worse. Some fleets of commercial vehicles weighing about 4 tons, including load, average only 5 miles per gallon of fuel, while others of equal weight and in about the same service average 12 miles per gallon, the differences being due partly to differences in design and equipment and partly to differences in the care with which the various adjustments are made and the operation of the vehicles is conducted.

Excuse for Waste. It should be noted that the automotive industry as it exists in this country is only about 10 years old. Not only have most of the engineers and manufacturers been trained in that brief period, but the rapid expansion of the use of motor vehicles has introduced new and untrained drivers at the rate of about 1,000,000 per year. The production of vehicles which meet the demands of these untrained users has made the building of really economical units doubly difficult.

Gasoline waste depends partly upon the quality or volatility of the fuel used for the reason that the volatility affects its adaptability as a fuel for the engine consuming the greater part of this product. But the greater the quantity of gasoline made from a barrel of crude oil, by any given process, the lower the volatility. The best interests of the public as well as of the automotive and oil industries will plainly be best served by obtaining a maximum amount of satisfactory fuel from each barrel of crude.

Summary of Factors Promoting Motor Fuel Economy. Several factors which promote fuel economy may be summarized briefly as follows:

(1) Universal adoption of means for maintaining the engine and the carbureter and intake system at the best operating temperature.

(2) The adoption as rapidly as possible of carbureting devices which can be adjusted once for all by the maker to supply automatically a correct amount of fuel as completely atomized as possible for economical operation under all conditions.

(3) An economically correct grade of gasoline supplied uniformly throughout the country, but suitably varied, if possible, to meet climatic conditions. Uniformity of fuel would go far to make possible the adoption of the more economical carbureting systems suggested above.

(4) Education of the user of motor vehicles to the advantages which will accrue to him through fuel economy. These advantages are in reality much greater than the saving in fuel cost. They include also less wear in the engine, less carbonization, less upkeep cost, and freedom from other minor annoyances.

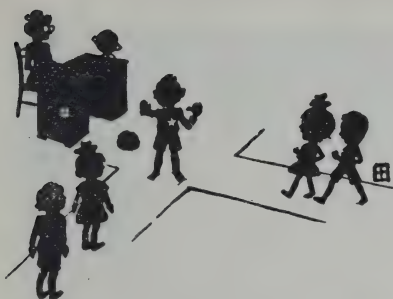
(5) The gradual adoption of engines using higher compression ratios with resulting higher fuel economy. This can be accomplished only as improvements in design or in quality of fuel make higher pressures possible without engine knock, which at present limits the useable compression pressures.

(6) Servicing of automotive equipment to maintain it in satisfactory condition for economy of operation. This refers to the entire vehicle as well as to the engine, and present conditions can be improved by education of the public and of the garage mechanic, and by improvements in the service facilities offered by the dealers.

All of these factors, except, perhaps, the education of the general public, are receiving a continually increasing amount of study by the Society of Automotive Engineers and the manufacturers, and we believe that much has already been accomplished in eliminating fuel waste. The necessity of meeting popular demands inconsistent with economy, and the difficulty of putting new developments into immediate production have retarded this accomplishment. Even more important, perhaps, is the fact that the average vehicle now in use is a product of two or three years ago, not of today.

"Auto Suggestions", Practical Helps for Winter Weather. Most autos are used 12 months in the year. They must be given special care during the winter months or they will deteriorate. Here are a few tips: (1) Change the oil (for lubrication) every 250 miles since the danger of gasoline passing the pistons and diluting the crank-case oil is then at maximum; (2), increase the charging rate of generator, lights and starter being used more in winter; (3), adjust carbureter to cold weather conditions so as to enrich the mixture; (4) thin out the oil in the rear axle and transmission by adding cylinder oil because cold, thick oil will not reach the bearings or gears; (5), have a set of tire chains always ready; (6), keep brakes evenly adjusted, for if one wheel is tighter a bad spill may result; (7), put alcohol in radiator, renewing it as needed till late spring.*

*Compiled by R. K. Jack, chief engineer, Olds Motor Works, and abstracted in the *Washington Daily News*, October 22, 1923.



1. Safety Education



2. Adequate Playgrounds



3. Jail for Speeders



4. City Planning



5. Traffic Regulation

FIVE WAYS TO PROMOTE SAFER STREET AND HIGHWAY TRAFFIC

According to "Facts & Figures", 1923, published by the National Automobile Chamber of Commerce, Inc., 368 Madison Ave., New York. This organization offers annually 3 prizes for teachers and 3 for pupils. For information write to the Highway Education Board, Willard Bldg., Washington, D. C.



THE SAFETY ESSAY WINNER IN 1922 OUT OF 400,000 ELEMENTARY PUPILS

Stanley U. Newcomb, then 13, was given a gold watch and a trip to Washington, where he was photographed on the steps of the Capitol between Mr. Coolidge, Vice-President at that time, and Mr. H. C. Johnson, Superintendent of Schools at San Diego (the home of the author). The others are: C. B. Dodds, Sec'y to Sen. Shortridge of California; and Stephen James of the Highway Education Board, at the left; C. L. Bawden of the U. S. Bureau of Education and N. C. Damon of the N. A. C. C., at the right.



WINNERS OF H. S. FIRESTONE SCHOLARSHIPS FOR GOOD ROADS ESSAYS

Kansas, one of two states that do not derive funds for aiding Federal highways from auto license or gasoline tax, supplied the successful contestant in 1922 out of 250,000 high school students. Karl G. Pearson, a Lindsborg lad and son of the author of "Surface Marks of Oil Deposits" (see Chap. II), is now enrolled in George Washington University after graduating from Eastern High School, Washington.

Kentucky, known for its fair women and fine horses, fittingly brought forth one of these winners—in 1923. Miss Dorothy L. Roberts, then of Harlan, in the heart of the Kentucky Mountains, is now enjoying her \$4,000 scholarship at Marietta College, Ohio. Her subject was, "The Influence of Highway Transport upon the Religious Life of My Community" (see extract below).



—Courtesy of Funk & Wagnalls Co.

"GASOLINE AND THE GOSPEL"

To judge from this view, reproduced from *The Literary Digest* of Oct. 27, 1923, church going in our cities is still a cherished custom, although church support takes hardly half the sum spent for gasoline alone. All car owners in the cities do not spend Sunday at the beach, in forest camp or on golf course. Great good will result from the growth in the use of motor vehicles in rural regions. Wrote Miss Roberts in her prize essay: "Good roads will encourage the auto truck, diversity of crops, improved farming methods, cooperative selling, contentment, and an increase of the economic surplus. This surplus will be invested in churches and schools. Good roads will mean fewer churches, but better, larger ones; fewer ministers, but better trained, educated community leaders."



Underwood & Underwood

OFFICIALS OF OILDOM AND GOVERNMENT GET TOGETHER FOR NATIONAL SAFETY AND PERMANENT PROSPERITY

From left to right, seated—President W. S. Farish of the Humble Oil and Refining Co., Secretary of War Davis, Secretary of Interior Work, Secretary of Navy Wilbur, President George S. Davis of the Gulf Refining Co., Standing—Chairman H. L. Doherty, of the Cities Service Company, and Walter C. Teague, President of the Standard Oil Company of New Jersey. The missing member of the Oil Conservation Board is Secretary Hoover. Mr. Farish had just succeeded J. Edgar Pew as president of the American Petroleum Institute before the hearing of the Board in February, 1926, when this photograph was taken. Mr. Davison was president of the American Society of Civil Engineers during 1926. See Chapter XI for details of the Cooperation of Industry and Government.

OILDOM

ITS TREASURES AND TRAGEDIES

A PROFUSELY ILLUSTRATED BOOK OF LATE
AND BASIC FACTS ABOUT PETROLEUM AND THE
DEPENDENT OIL AND AUTOMOTIVE INDUSTRIES

POPULARLY PRESENTED FOR THE BENEFIT OF INVESTORS, MOTORISTS
AND OPERATORS

By OSCAR H. REINHOLT, B. S.

Engineer and Geologist; Specialist in Mineral Resources; Co-Editor, Revised "Manual for
the Oil and Gas Industry," United States Treasury Department, 1921; Member,
American Academy of Pol. and Soc. Science, American Institute Min.
and Met. Engineers, Geological Society of Washington, D. C.
Eighth International Geographic Congress

PART TWO

Covering Finance, Geography, Governmental Relations, The Human
Element, Latin America and the Prevention of Failures

David McKay Co., Publishers
South Washington Square, Philadelphia
Price, \$3.00 postpaid.
Price of both parts in one binding, \$4.00.

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PUBLISHER'S STATEMENT

In presenting to the public this long expected second part of Mr. Reinhold's unique work, a few explanatory words seem called for.

Part Two is complete in itself and does not demand previous acquaintance with Part One for its understanding, enjoyment and utilization. Indeed, this is largely true of every chapter in both parts; each is more or less an independent treatment of one phase of the almost fathomless subject, Oil; any one of them, without the others, may be consulted with profit should time or interest be limited.

In regard to the Author's *purpose*, that has been fully stated in the preface to Part One as the "Conservation of Capital." He has kept this in mind while preparing Part Two. What shall it profit our people if the legitimate industry in cooperation with the Oil Conservation Board shall prolong the life of our petroleum deposits and, on the other hand, the investing public shall squander capital by encouraging inexperienced interlopers and dishonest promoters? Since natural resources may be converted into capital, Mr. Reinhold has incidentally emphasized that full and timely utilization of oil, while it is cheap, will indirectly advance the cause of capital saving. Unfair criticism has often been leveled at leading operators and the industry as a whole. But if publicists and politicians had more correct information at their command most of the abuse and condemnation would be avoided. Some of the facts given in this volume invite fairer treatment of that industry which supplies efficient motor fuel for more than twenty million American trucks and automobiles.

As to the exceptionally wide *scope* of this work the reader is referred to the Outline of Contents as well as to the comprehensive Index. As to the *preparation* it may be stated that the Author, in the course of many years accumulated a vast file of valuable oil literature not contained in books. From these data he has deliberately selected the best material for use in *OILDOM: ITS TREASURES AND TRAGEDIES*. He has traveled extensively for the Government and on his own account, not only visiting all the major oil fields in the United States and Mexico but also attending many conventions of engineers, geologists, producers and marketers. In devoting a quarter of a page to a review of Part One, the *London Oil News* noted that it appeared to be "a good and workmanlike contribution to popular knowledge." As to the *treatment*: A topic in bold type introduces almost every paragraph, and outstanding facts clearly and concisely stated make this story of oil easily understood by the layman. Statistics—in round figures or large units—are readily digested. A California critic designated Part One as "a valuable reference volume, written in a readable style, free from technicalities."

Whatever the various causes for the delay in publishing Part Two, the procrastination has permitted the inclusion of much interesting matter that might otherwise have been omitted. Deferring the issuance of this part to early 1927 made the contents quite down to date. Future editions will inform about other operators than those herein described.

May this unusual assembly of important facts provide substantial service to thinking, thrifty people who appreciate the recent *truths* about a world-wide business of greatest benefit to the American people whether considered as consumers, investors or workers.

Philadelphia, January 31, 1927.

CONDENSED TABLE OF CONTENTS

PART ONE—FIRST SEVEN CHAPTERS

I. **THE PETROLEUM PANORAMA**—International Treasures and Tragedies; World Reserves, etc.

II. **THE NATURAL RESOURCE**—Origin of Oil, Geological Occurrence and Distribution, etc.

III. **COMMERCIAL GEOLOGY**—Description of the Major American Oil Fields; Canadian fields.

IV. **MECHANISM OF THE INDUSTRY**—Drilling, Producing, Transporting, Refining; Core Drilling.

V-VI. **ECONOMIC ASPECTS**—Brief History, Recent Overproduction; Price Variations, Review, etc.

VI. **GASOLINE AND THE AUTOMOTIVE INDUSTRY**—Three Sources of Gasoline, Growth, Conservation.

PART TWO—LAST SEVEN CHAPTERS

VIII. **GEOGRAPHY OF PRODUCTION AND REFINING**—Treasures and Tragedies, Geography of Soil versus Geography of Oil, Depletion Compels Shifting in Sources, Tulsa near U. S. Center of Production, Los Angeles the Leading Port in Domestic Trade, Import Traffic of Oil Ports; World Sources, Production by Major Fields and Pools, Seven States More Than Five Foreign Countries, Output per Well; Oil First in the Mineral Industry of Many States; Petroleum in the "Big Three" States, California, Oklahoma and Texas; Production of Natural Gasoline by States; Distribution of Refineries.

IX. **GEOGRAPHY OF THE MARITIME TRADE**—Preponderance of Tankers in Merchant Marine, Movement through Panama Canal, Oil in American Bottoms, Tonnage of Foreign Trade, Where Imports Enter and Exports Depart; The World's Greatest Buyer of Crude Oil; Decreasing Imports of Crude. Position of Petroleum in Import Trade; Oil Great Force in Export Trade in General; Importance of Maintaining Export Trade in Oil Products, Mineral Oil next to Cotton, Federal Interference Proposed; Our Best Customers for Crude and Refined Oils; British Petroleum Trade, 1923-1925; World Consumption.

X. **LATIN AMERICA, LATENT AND PRODUCING**—Leadership in Many Lines; Panama and Petroleum; World Trade, Trade with the United States, Oil as a Factor in Commerce, U. S. Imports from Mexico below 50 Million in 1926; Geologic Occurrence and Characteristics of Petroleum, Delayed Development, Recent Quickening, Deficiency in Coal; Cuba, Curaçao and Trinidad; Central America, Ecuador and Bolivia; Chii, the Coal Producer; Brazil, the Unexplored with Big Shale Deposits; Argentina Active at Comodoro Rivadavia; Peru till Second in South American Oil, Negritos Its Leading Field, American Capital; Colombia Coming to the Front with Completion of 360-Mile Pipe Line; Venezuelan Geology, Maracaibo like California; La Rosa and Mene Grande, Venezuela Advancing Rapidly, Now Fourth Among Oil Nations, British Dominance; Mexico, Land of Silver, Sisal Hemp and Heavy Oil; Happenings of 25 Years in Oil; World's Greatest Gushers; Comparison of Mexican with American Oil Fields; Production and Trade in Petroleum; Tampico, Taxation, etc.

XI. **GOVERNMENTAL RELATIONS**—Manifold Activities Helpful to Producers, Consumers and Government; Bureau of Mines and Department of Commerce; Geological Survey and Interior Department; Governmental Needs and the Navy Department; Conservation Work Accomplished and Required; The Oil Conservation Board and Its First Report with Addresses of Leading Oil Men.

XII. **HUMAN FACTORS AND BENEFICIARIES**—The Men Who Toil and Win the Oil; the Men Who Find through Well Trained Mind; Ladders to Leadership; Hazards and Heroes, Company Care, Profit Sharing; Consumers the Principal Beneficiaries, Osage Indians World's Wealthiest Tribe; How Oil Men Helped to Win the War; the American Petroleum Institute a Permanent Result.

XIII. **FINANCIAL SURVEY AND INVESTMENTS**—A Bird's-Eye View of the Business; Benefits, Assets, Who's Who; Operating Costs and Capital Expenditures; Fuel, Power and Electrification; Geological Work, Leasing, Core Drilling; Cost of Drilling and equipping Wells; Cost of Producing Crude Oil; Margin between Cost and Market Value; Valuation of Oil Properties with Data on Some Sales; Depletion and Depreciation; Current Supply and Demand; Financial Losses and Conservation; Conservation through Combinations; Larger Units Benefit Consumers and Workers, Memorable Period of Mergers, Their Motives, East Weds West, General Petroleum to Standard of N. Y.; Earnings of the Entire Industry, Refining More Stabilized than Production, Increasing Gross Income; Income and Profits of Leading Operators, Gross Sales of 12 Companies, Net Profits of 26 Operators, Net per Share, Percent Profit of Par, Dividend Rates More Regular; A Type Study in Oil—The Texas Company; Comparisons with Gulf Oil, Humble and Standard of Indiana; Other Substantial Operators; Refiners and Marketers in the Philadelphia District; Financing the Industry; Sudden Need for New Capital, Threefold Function of Surplus, Capital Increases; Making Money in Oil, Wildcatting Hazardous; Investing in Oil Securities versus Speculating; Shares of Going Concerns, Dividends Paid in 1925; Ratio of Current Assets to Current Liabilities; Financial Review of 1926 and Past Years.

XIV. **PREVENTION OF FRAUDS AND FAILURES**—Why Rogues and Ignoramuses Prey on Petroleum; A Ten-Year Tale of Tragedy; General and Specific (45) Causes of Oil-doom Wrecks; Why Small Refiners Fail; Prevention of Failures; How to Win in Wildcatting; Blue-Sky Laws and Ear Marks of Fraud; Hammond's Ten Don'ts; Questionnaire of the Better Business Bureau.

OILDOM:

ITS TREASURES AND TRAGEDIES

By OSCAR H. REINHOLT

PART TWO

CHAPTER VIII—GEOGRAPHY OF THE DOMESTIC INDUSTRY—PRODUCTION AND REFINING

"The barrens of the Mackenzie basin and the frozen wastes of Chilkat now vie with the tropical jungles of Central and South America in luring the locator of petroleum. Whether you describe the oil seeker as a geologist or as a scout he is also a geographer. Likewise, foreign sales present a further requirement of familiarity with geography. Probably in no field of commerce has America been so important a factor as in the world markets for mineral oil. In this phase of the business one must know the countries, their peoples, their customs of living, of doing business, and of financing operations. This takes one, not to the hinterland, as it does the scout, but to the capitals, the industrial centers, and the waterways."—*The Texaco Star*, April, 1923.

INTRODUCTORY

Geographic Treasures and Tragedies. There are geographic as well as financial tragedies attached to the legitimate petroleum industry, but they are trivial compared with the tragedies arising from oil-stock promotions. The unique shifting of the oil and gas centers of production may prove either a bane or a blessing. Tragedies take place in the abandonment of towns overbuilt because of ignorance, greed, over-optimism, or lack of foresight. Occasionally fertile farm lands have been more or less ruined by the flooding of the surface with oil from great gushers thus urging the owners to settle elsewhere. However, "deserted villages" do not dot the landscape of oildom so numerous as they do the western world of gold and silver Golcondas. By no means do the geographic tragedies outweigh the geographic treasures in oildom. The industry is becoming more and more one of pioneering in new or unsettled places and often leads to the development of other and more permanent natural resources such as coal, potash and water-power (see pages 30 and 63 and foot note 102). Some cities owe their growth if not their birth in part to the development of tributary territory rich in gas and oil. Pittsburgh owes largely to natural gas her great glass industry. Tulsa would probably not be known outside of Oklahoma were it not for the petroleum industry. Elsewhere references relate to Baltimore, Casper, Fort Worth, Galveston, Houston, Los Angeles, Port Arthur, Shreveport, Tampico, Wichita and Wichita Falls.

Geographic knowledge of foreign lands has been obtained through the oil industry in two ways. For at least thirty years American well drillers have been going abroad. Their letters get wide publicity in their home papers, particularly throughout the Appalachian oil fields where many of them were trained. Also, in the course of a half century, American petroleum products have been carried into the far corners of the earth. In a double sense they have served as the "Light of Asia," for knowledge of the United States has followed in the wake of illuminating oil. American tankers, cargo vessels and commercial travelers connected with our

exporting oil companies* have continually returned with most interesting information about distant lands.

Geography of Soil versus Geography of Oil. The fundamental geographic differences between ordinary mining and farming are not so emphatic in the case of oil and coal production.† As indicated in Chapters II and III and on pages 40 and 63-64, geologic and not climatic conditions govern the geographic distribution of oil and gas deposits. Farming may be followed but no petroleum produced in purely volcanic, granitic and metamorphic regions. Neither bituminous coal nor oil may be obtained from stratified rocks that have been violently bent and broken. Metal mining states in general are not noted oil producers. The few large states that yield both do so in widely separated sections. Noteworthy exceptions are the lead-zinc states, Oklahoma and Kansas, since there the ore bodies occur in sedimentaries.

Depletion the One Outstanding Difference. A contrast between agriculture and the mineral industry concerns depletion. Fertility of the soil may be renewed, but mineral deposits once depleted are irreplaceable. Therefore the most striking fact in the economic and commercial geography of petroleum is the everlasting shifting in the sources of supply. In the course of a quarter century the center of crude oil output has migrated from the upper Ohio valley to the vicinity of the Texas Panhandle, a distance of about 1,000 miles. Oil pools are now more quickly developed and exhausted than ever before; and wild-catting over wide areas increases the number of new fields and pools that may be found within a single year. But petroleum will not forever be mined by the well method in the United States; and so other geographic shiftings may be foreshadowed. Many a deserted oil-town, with its industrial tombstones of derricks, may some day be repopulated when the partly depleted sands shall themselves be mined for their remaining oil content (pages 42-43).

Another Geographic Difference. Agriculture is extensive, oil production is intensive. All states contain cultivated areas and yield farm crops of one kind or another; but 30 states in 1924 failed to produce any crude petroleum, and three out of 18 that gave forth the combustible liquid contributed three-fourths of the entire quantity. Such concentration is quite unique and is approached only in the production of natural gas, gold, iron ore, copper and zinc among the major mineral products and in the production of aluminum ore, borax, graphite, manganese ore, marble, phosphate rock, potash and sulphur among the minor mineral products.

DOMESTIC CENTERS OF PRODUCTION, REFINING AND COMMERCE

Tulsa Nearest to National Center of Production. Production centers shift as already shown, but refining points, particularly those located at oil ports,

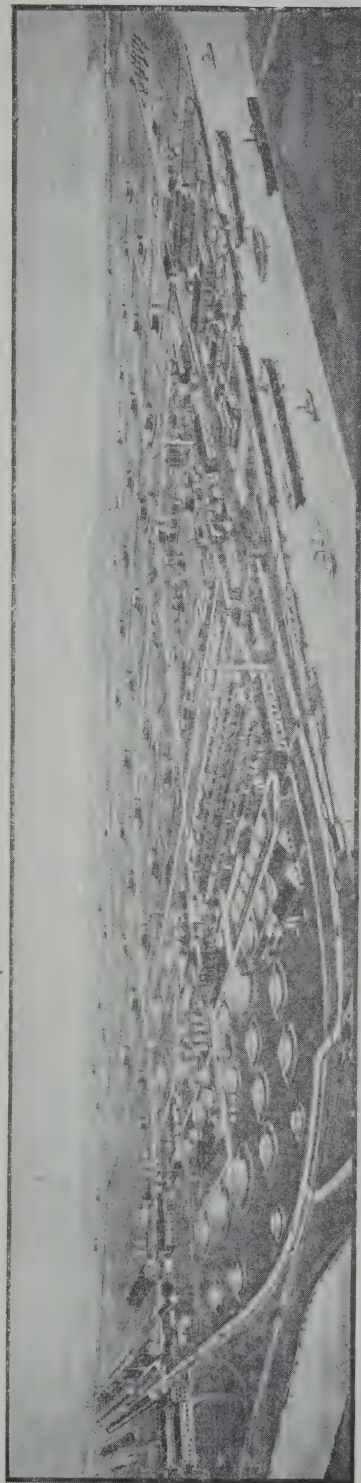
* The house journals of these operators (such as *The Lamp*, *The Texaco Star*, *Union Oil Bulletin* and the *Bulletin* of the Standard Oil Company of California) often contain highly instructive, illustrated articles not only about the petroleum trade but also about other matters of geographic value. The photographic views in this book imply how wide a geographic range is covered by the American petroleum industry.

† Thus in regions of relatively undisturbed sedimentary rocks agriculture may persist on the surface while oil wells may tap the wealth beneath the soil. Texas is primarily given over to farming and grazing; but in the fall of 1923, and again in January, 1925, it temporarily took second place as a producer of petroleum. During the last four months of 1926 the "Lone Star State" stood next to California, and even ranked first during a few weeks.



TULSA, A TWENTIETH CENTURY MARVEL, THE CAPITAL OF OILDOM

The skyline of early 1925. The tallest structure is the Hotel Mayo, headquarters of the Petroleum Congress, attended by the author, October, 1925. In the lower right-hand corner appears the Tulsa High School, one of the best equipped and best taught institutions in the United States. Tulsa was a struggling, struggling town until 20 years ago, when petroleum development began its transformation.
—Courtesy of the Tulsa Chamber of Commerce.



THE LARGEST INDEPENDENT REFINERY IN THE WORLD, AT PORT ARTHUR, TEX., OWNED BY THE GULF REFINING CO.
Capacity 102,000 barrels daily (see page 170). The same (Mellon) interests lead all independents in the production of crude oil, averaging 180,000 barrels daily (85 percent as much as all Mexico) during the second half of 1926.

are relatively permanent. The cities of Los Angeles and Tulsa are apparently tied for first honors for consideration as the oil capital not only of this country but of the entire world. Tulsa, like Tampico in Mexico, has depended almost entirely on petroleum for its great growth in recent years—more than five-fold in less than 15 years—so that its population now numbers over 100,000. Tulsa is likely less than 200 miles northeast of the geographic center of oil production in the United States, and in practically every sense is the center of the Mid-Continent, the first of all the seven major oil fields of this country. Here are located the homes of more important oil companies than in any other city of its size; and here was held the first international petroleum exposition during the fall of 1924.

Los Angeles World's Leading Oil Port. On the other hand, Los Angeles is less exclusively an oil city* though for the time being its Port of San Pedro is preeminent in combined foreign and domestic shipments of petroleum (see pages 21 and —). These shipments, to the east coast, west coast and foreign countries, at one time during 1923 proceeded at the rate of more than 400,000 barrels daily, or about 150 million barrels yearly. Before 1923 no state had produced crude oil at quite so high a rate.

Unique Location of Los Angeles in a Derrick-decked Domain. One of the few well-founded boasts of both real estate and oil stock venders in southern California has probably never applied to any other city in the history of the world's oil industry. From the hills of Los Angeles one could, during 1923, look out over the slopes and lowlands from the Puente Hills to the Pacific beaches and discern the derricks of fewer than 4,000 wells from which was flowing collectively a quantity of petroleum so immense as to make for the entire year of 1923 more than 20 per cent of the world's total and almost 30 per cent of the total for the United States. Nevertheless, and in spite of the author's attachment to his former home city, it must be admitted that Tulsa is geographically the oil capital of our country as acknowledged by a majority of oil men. Both California and Oklahoma have other cities that are very important in the oil industry, such as Bakersfield in the former and Bartlesville in the latter.

Many Municipalities Dependent on Mineral Oil. Houston, in Harris County, has grown a little faster than the other three largest cities in Texas largely because of its proximity to the Gulf Coast pools. Neither Dallas nor Fort Worth are quite so near to producing fields. San Antonio has its Somerset on the border of Bexar County, but it is about as distant from Luling as Dallas is from either Powell or Wortham. Wichita Falls is unquestionably the headquarters of northern Texas—Burkburnett, Electra, and Holliday, as Corsicana is for East Central Texas—Mexico, Powell and Wortham pools. Wichita is the logical oil capital of Kansas, El Dorado of Arkansas, Shreveport of Louisiana, and Casper of Wyoming. In the case of states east of the Mississippi it is not an easy matter to select the various state centers of production. Lima, Ohio, is the admitted commercial center of the Trenton or Lima-Indiana field, but Toledo is the leading refining center of the state, its four refineries having over twice the capacity of the two at Cleveland or three times the lonely one at Lima. Los Angeles, Oil City (Pa.), and Pittsburgh are prominent in the manufacture and distribution of oil field equipment; so also Parkersburg, W. Va.

* See "Petroleum Refineries in the United States," November 1, 1924, January 1, 1926, published by Bureau of Mines, recently transferred from the Interior Department to the Department of Commerce.

Los Angeles the Most "Refined" Metropolis. In point of refining capacity only five of the first fifteen refining centers are known nationally outside of the oil fraternity. Bureau of Mines data show that the 12 leading refinery cities, each with a daily capacity of about 50,000 barrels or more, are as follows: Port Arthur, Tex.; Bayonne, N. J.; Richmond, Calif.; El Segundo, Calif.; Baton Rouge, La.; Vernon, Calif.; Wilmington, Calif.; Philadelphia; Whiting, Ind.; Tulsa and West Tulsa; Casper, Wyo.; Wood River, Ill.; Avon, Calif.; Baltimore, and Los Angeles. El Segundo, Vernon and Wilmington may all be considered as suburbs of Los Angeles; and if the combined capacity of the scattered plants throughout southern Los Angeles County be included, then Los Angeles is now the leading refinery center of the world, with a total potential of about 375,000 barrels daily. This made half of California's total or one-eighth of the national capacity, May 1, 1925.

Import Traffic of Oil Ports. While Port Arthur (including Sabine Pass) is the most exclusive oil port in the United States, Galveston stood at the top during the past year (1924) in the matter of crude oil imports. The figures following the names of the ports indicate in millions of barrels the receipts of unrefined oil from foreign lands: Galveston, 19; New York, 17; New Orleans (including Baton Rouge), 15; Port Arthur (including Sabine Pass), 7.5; Baltimore, 7; Boston, 5.5; Philadelphia, 5; Tampa, 1.6; all others, 12; total, practically 90,000,000 barrels. However, the aggregate water receipts of crude oil at the port of New York in 1924, including those from California (30,000,000 barrels), reached the quantity of 47,000,000 barrels, or nearly three times the total receipts at Galveston, which did not get any oil from California.

Export Traffic of Oil Ports. New York is still supreme in the quantity and value of refined mineral oil exported. But in the quantity of crude, topped and refined petroleum carried away by water to both domestic and foreign destinations San Pedro, the port of Los Angeles, has "lassoed" the world leadership for a few years at least. With new discoveries near Tampico, in time that foremost Mexican port may recapture her queenship in petroleum shipments.*

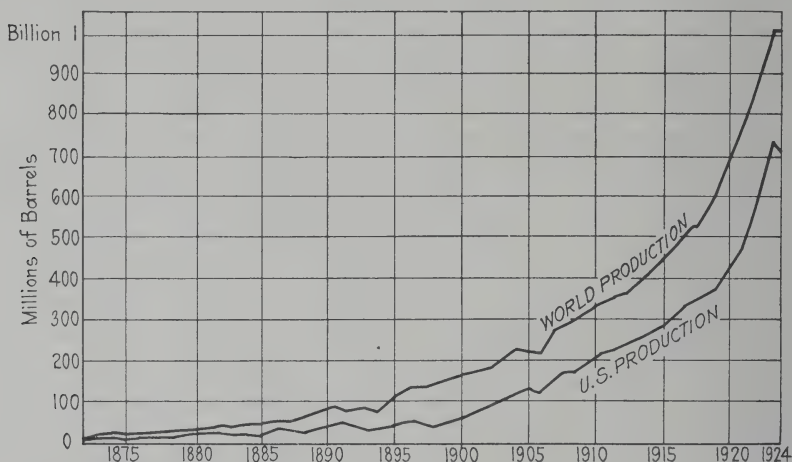
PRODUCTION OF CRUDE OIL

1. WORLD SOURCES

Tremendous Total to End of 1924. During the past two-thirds of a century the entire earth has produced over 12,000,000,000 barrels of oil. To visualize this large amount of liquid it may be stated that to run the same volume of water would take the Potomac at the "Niagara of the South" about 135 days or four and one-half months at its summer rate of flow (compare page 61). Practically all came from countries located north of the Equator. Two-thirds of the huge total emanated from the United States in the course of 65 years. One-sixth, or 2,000,000,000 barrels, originated in Russia, beginning about 62 years ago. A little over one-tenth—

* In regard to combined outbound and inbound water-borne traffic the five foremost seaports in 1924 handled cargo tons of 2,240 pounds as follows, in millions, according to the Chief of Engineers, U. S. Army, and published January, 1925, in *Southern California Business*, organ of the Los Angeles Chamber of Commerce: (1) New York, 48; (2) Los Angeles, 27.2; (3) Philadelphia, 15.2; (4) New Orleans, 10.3; (5) Baltimore, 10.2. The figures for 1922, on page 20, are exclusive of coastwise or domestic traffic. Petroleum is still the most important commodity considering quantity alone, in the foreign trade of those cities.

1,200,000,000 barrels—came out of the ground in Mexico in hardly a quarter of a century. The significant facts are these: Nearly half of the world yield to date was obtained during the past eight years, or in one-eighth of the total time in which it has been producing; half of the output of the United States was gotten in the same period; but two-thirds of Mexico's mined mineral oil was produced during the five-year period, 1920-1924. (See pages 14 and 19.)



Current Output of Leading Countries. All geographic units contributing half a million barrels or more of crude oil in 1924 are listed below, the figures representing millions of barrels. It will be observed that the United States produces more than twice as much as all the rest of the world.

Country	1923	1924	Per- cent 1924	Country	1923	1924	Per- cent 1924
United States.....	735	718	70.6	Peru	5.7	7.8	0.8
Mexico	150	140	13.7	Poland (Galicia)....	5.4	5.7	.6
Russia	39	45	4.3	British Borneo.....	3.9	4.5	.4
Persia	29	32	3.1	Trinidad	3.0	4.3	.4
Dutch E. Indies.....	20	21	2.0	Argentina	3.4	3.8	.4
Rumania	10.9	13.3	1.3	Japan	1.8	1.6	.2
Venezuela	4	9.5	.9	Egypt	1.0	1.1	.1
India	8.3	8.2	.8	Colombia .....	.4	.5	.05

The United States apparently passed its peak in 1924, the first year since 1906 to show a loss, but 1925 and 1926 set new records. Mexico lost in 1924 as much as the next three countries gained. Rumania gained twice as much as the Dutch East Indies. But the big surprise was Venezuela which more than doubled her output in the course of twelve months, rising in rank from tenth in 1923 to seventh in 1924. Colombia managed to keep her place as the sweet sixteenth just ahead of France. The year 1925 led to further changes, such as Peru passing India and Venezuela outranking Rumania. Venezuela became fourth in 1926.

New Peak in 1925; Gain of 50 Million. Unexpectedly the United States surpassed its 1923 peak of 735 million through an increase of 50 million over 1924. This boosted the world total by little more than the same amount making the output of all countries in 1925 fully 1,065 million barrels, and increasing our contribution from 70.5 percent to 71.6 percent. South

America's advance failed to offset Mexico's loss of 25 million barrels. The 1925 order of producing nations appears as follows:

Country	Million barrels	Pct.	Country	Million barrels	Pct.
United States	764	71.6	Argentina	6.5	.6
Mexico	115	10.8	Poland	5.7	.5
Russia	52	4.9	Br. Borneo	4.3	.4
Persia	34	3.2	Trinidad	4.3	.4
Dutch E. Ind.	22	2.0	Japan	2.0	.2
Venezuela	20	1.9	Egypt	1.2	.1
Rumania	16.1	1.5	Columbia	1.0	.1
Peru	9.1	.9	France .....	.5	.04
India	8.0	.8	Germany .....	.4	.04

Canada, due to a "gasoline" well near Calgary, contributed more petroleum than all the rest of the world not included above.

2. DOMESTIC SOURCES—THE MAJOR FIELDS AND POOLS

Production by Major Fields. During the past decade the Mid-Continent field has been contributing fully 50 per cent of the annual output of crude oil in the United States. The leadership of this large area is more pronounced on the basis of value. This is due largely to the fact that the average quality of the oil is superior to that generally produced in California, the next most important geographic division of first order.

Field	Millions of barrels				Percent of total			
	1921	1922	1923	1924*	1921	1922	1923	1924
Mid-Continent	258.5	311.0	348.5	368.7	54.8	55.8	47.5	52.0
California	112.6	138.5	263.7	230.1	23.8	24.8	36.0	32.6
Rocky Mountain	21.0	29.3	47.6	42.8	4.4	5.3	6.5	6.1
Gulf Coast	36.4	37.1	33.3	27.6	7.7	6.7	4.5	3.9
Appalachian	30.5	29.2	28.2	27.0	6.5	5.2	3.9	3.8
Illinois-S. W. Indiana...	10.9	10.2	9.5	8.7	2.3	1.8	1.3	1.3
Lima-Indiana (Trenton) .	2.4	2.3	2.4	2.3	.5	.4	.3	.3
	472.3	557.6	733.2	707.2	100.0	100.0	100.0	100.0

The first two fields have a current control six-sevenths, or well above 80 per cent, of the total. By reason of their huge reserves (see page 39) they may still be yielding 70 to 75 per cent of the total towards the middle of this century. Notwithstanding the hitherto known advantage of the Gulf Coast field in the matter of reserves it is doubtful if it will displace the Rocky Mountain region in third rank for many years in view of the recent discoveries in Colorado, Montana and New Mexico. Since production began and up to January 1, 1925, the aggregate output, in millions of barrels, may be considered to be as follows for each of the seven major fields: Mid-Continent, almost 3,000; California, nearly 2,100; Appalachian, almost 1,400; Gulf Coast, 500; Lima-Indiana, 465; Rocky Mountain, 225; Illinois-S. W. Indiana, 360.

Production by Major Pools. Of pools in the United States yielding a daily average of 15,000 barrels or more there were 29 in January, 1925, or five more than 12 months before. Their combined output made 63 per cent of the country's total compared with 68 per cent in January, 1924. This evidences the falling off in the flush production of the eight major pools, all of which reached peak output above 100,000 daily each during 1923. In other words, to maintain production without more than the two per cent decrease in the complete total, about 718,000,000 barrels in 1924, required a greater number of pools. During the past year (1924) Burkburnett dropped behind; likewise three temporary major pools of that year, namely Graham-Fox and Stroud in Oklahoma, and Richland in Texas.

* Preliminary figures of the U. S. Geological Survey which will be increased about 1 per cent later to include oil used in drilling, etc., where produced.

Among more permanent major pools added during 1924 were Coyote and Dominguez in California, Cromwell and Papoose in Oklahoma, and Luling and Wortham in Texas. The following table gives the average daily yield in barrels for each of the 29 major pools during January, 1925, also the average gravity of the oil in degrees Baumé.

Average daily				Average daily			
State and pool	Total	Per well	Gravity	State and pool	Total	Per well	Gravity
Arkansas:				Oklahoma:			
Smackover*	78,180	37.3	22.0	Tonkawa	96,334	132.0	42.0
California:				Cromwell	33,147	132.6	38.5
Rosecrans			38.3	Papoose	35,257	446.3	38.5
Santa Fe Springs..	39,554	139.6	43.5	Cushing*	23,367	9.0	38.0
Dominguez	56,982	1,295.0	31.5	Burbank	58,644	34.0	37.5
Long Beach	122,297	229.0	25.0	Bristow	28,153	19.4	34.0
Montebello	19,423	123.0	24.0	Hewitt	16,246	20.5	33.0
Huntington Beach.	41,673	134.9	23.0	Healdton*	15,548	8.1	30.0
Midway-Sunset* ..	105,918	35.9	22.5	Texas:			
Elk Hills	37,019	141.8	22.0	Wortham	113,336	792.6	39.0
Torrance	41,788	77.9	22.0	Holliday	36,298	23.7	39.0
Coyote	20,242	88.4	22.0	Electra	17,587	7.2	38.5
Coalinga*	22,402	21.8	16.0	Powell	59,301	73.9	37.0
Kern River*	17,783	8.2	13.0	Mexia	20,439	43.3	36.0
Louisiana:				Luling	30,720	91.7	30.0
Haynesville	15,184	22.1	...				
Wyoming:				Total, 29 pools..	1,284,332	45.6	...
Salt Creek	56,166	41.5	37.0				

Smackover smashed all American records for a daily production of a single pool during the week ended May 16, 1925. The average daily deluge climbed to the unheard of high level of 431,000 barrels. This was nearly 90,000 barrels above the best week's average for daily output of either Powell or Santa Fe Springs in 1923.

Late Rank of the Leading Pools. Wortham, in Freestone County, Texas attained the temporary leadership in January, 1925. Almost directly it dropped behind both Long Beach and Midway-Sunset of California. Its peak of 167,000 barrels daily, as well as the earlier and greater peaks of Powell, Santa Fe Springs, Cushing and Long Beach, was completely eclipsed three months later by Arkansas' sensational pool, Smackover.

RELATIVE RANK OF LEADING AMERICAN POOLS EARLY IN 1926 AND MIDDLE OF 1925

(Average daily yield for two weeks given in thousands of barrels)

Pool or field	June, 1925	Jan., 1926	Pool or field	June, 1925	Jan., 1926
Smackover, Ark.....	265	170	Garber, Okla.....	..	31
Long Beach.....	108	112	Archer Co., Tex.....	40	30
Midway-Sunset	104	93	Elk Hills.....	38	30
Inglewood	78	60	Dominguez	31	24
Salt Creek, Wyo.....	55	60	Rosecrans	23	24
Santa Fe Springs.....	52	51	Cushing, Okla.....	22	22
Huntington Beach.....	44	46	Luling, S. W. Texas.....	24	21
Burbank, Okla.....	57	45	Ventura-Newhall	24.5	..
Tonkawa, Okla.....	58	43	Coalinga	21	..
Corsicana-Powell, Tex.....	47	34	Coyote	21	..
Big Lake, W. Tex.....	30	33	Davenport, Okla.....	..	20
Torrance	36	32	Cromwell, Okla.....	35	20
Bristow-Slick, Okla.....	35	32	North Okmulgee, Okla.....	..	18

3. DOMESTIC SOURCES—THE INDIVIDUAL STATES

Noteworthy Changes in Yearly Yield. During the year 1924, California broke the record for fall in annual output. The loss was enormous, amounting to more than 30 million barrels. No foreign country—except Mexico in the year 1923—ever sustained so large a loss in a single year. This quantity even exceeded the tremendous total of about 20 million barrels, which measured the decrease in crude oil output for the entire country

* Rearranged from table in *The Oil and Gas Journal*, March 5, 1925. Pools marked with an asterisk have a remarkably steady rate of yield, though low per well. Except Cushing and Electra, all of these produce heavy oil.

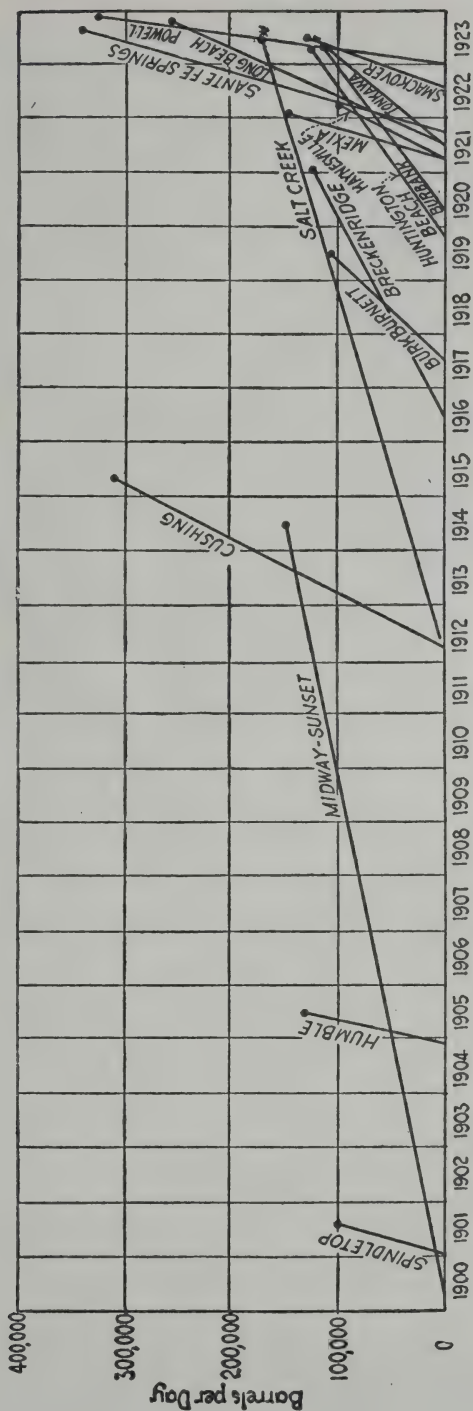
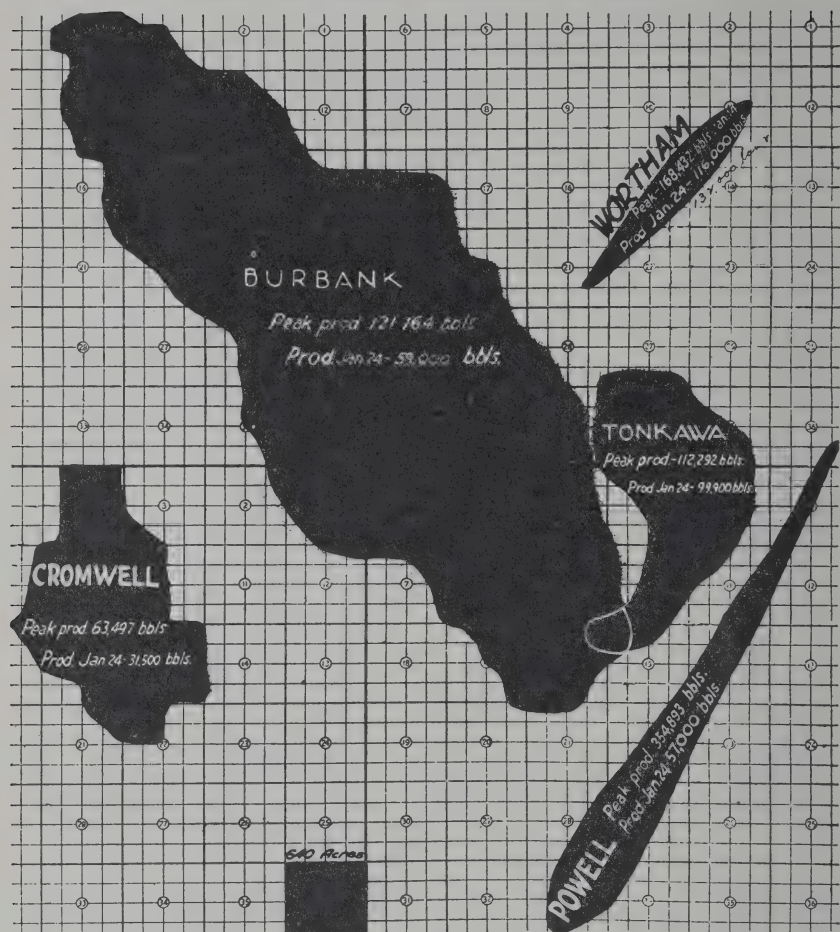


CHART SHOWING DATES OF DISCOVERY AND PEAK PRODUCTION OF ALL OIL POOLS IN THE UNITED STATES WHICH, BEFORE 1924, HAD REACHED A DAILY RATE OF OUTPUT OVER 100,000 BARRELS. The peak for the Salt Creek pool (*) was based on the proven potential and not on actual pipe-runs. Since 1923 only two new pools have passed the 100,000 mark, namely, Wortham in Texas (186,000 barrels peak in January, 1925), and Ingleswood in the Los Angeles basin (110,000 in August, 1925). Smackover smashed to smithereens all previous peak records (its own of about 130,000 in June, 1923, and over 140,000 in May, 1924; that of Cushing, 315,000 in April, 1915; Santa Fe Springs, Calif., 342,000 in August, 1923; Powell, Tex., 354,000 on November 13, 1923) by developing a new sand (the Graves), 300 to 400 feet below the Nacatoch (or from depths of 2,350 to 2,450 feet) and in sixty days bringing the daily yield from 100,000 barrels up to the prodigious peak of over 435,000 at the middle of May, 1925. Result, a new peak of over 2,350,000 for the entire United States was established as the daily average for the week ended May 16. Only one other pool in the world, the Toteco-Cerro Azul in Mexico, has ever produced more oil in one day. It production culminated on December 22, 1921, at 516,000 barrels. The most striking fact brought by this chart is that, out of 16 major oil pools found in the first 64 years of the American petroleum industry, eight reached their peak within a period of seven months in the single year of 1923.—Joseph E. Pogue in "The Production of Petroleum in 1923," A. I. M. E., 1924

COMPARISON OF FIVE LARGE PRODUCING AREAS



The above interesting illustration of the comparative area published through the courtesy of the Sinclair Consolidated very sections occupied by the Burbank Field in Townships Counties in Oklahoma and the exact area in Township 12-8, The long and narrow Powell Field in Navarro County, Texas, string" area of Wortham, in Limestone and Freetone Counties, two Oklahoma fields.

Southern Kay and Northern Noble Counties has been added been necessarily outlined in white so as not to take away

and contour of five of the big Mid-Continent Oil Fields is Oil Corp. The engineer who made the drawing marked out the 27-5, 27-6, 26-5, 26-6 in Eastern Kay and Western Osage Seminole County, Oklahoma, occupied by the Cromwell Field. shaped like the war club of a caveman and the smaller "shoe- Texas are drawn in exact shape, and on the same scale as the

The comparative shape and size of the Tonkawa Field in to the original map, the southwest edge of the field having from the true contour of the Burbank Field.

in 1924. In fact, the change in California's contribution not only surpassed the total loss sustained by the United States in 1924 by the approximate amount of Oklahoma's increase of 10 million barrels, but it alone accounted for the first decrease in this country's yearly yield since 1906, when the loss was a little less than eight million barrels. The increase in 1925—50 million over 1920—can be credited to three states almost entirely: Arkansas, with a gain of 29 million; Kansas, 9.5 million; and Texas, 8 million.*

* Only three states have ever registered a greater gain than 29,000,000 barrels in one year: California, 125,000,000 in 1923; Oklahoma, 35.6 million, 1922; Texas, 31.4 million, 1919. In 1917 Kansas increased her output of crude 27.8 million, or very little less than Arkansas in 1925. California's increase in 1923 was two and one-half times the whole country's gain in 1925, and 10,000,000 more than Mexico's output in 1925. California's loss of over 30,000,000 in 1924 approximated Persia's current yearly yield. The gasoline content thereof could operate 1,000,000 automobiles 12 months.

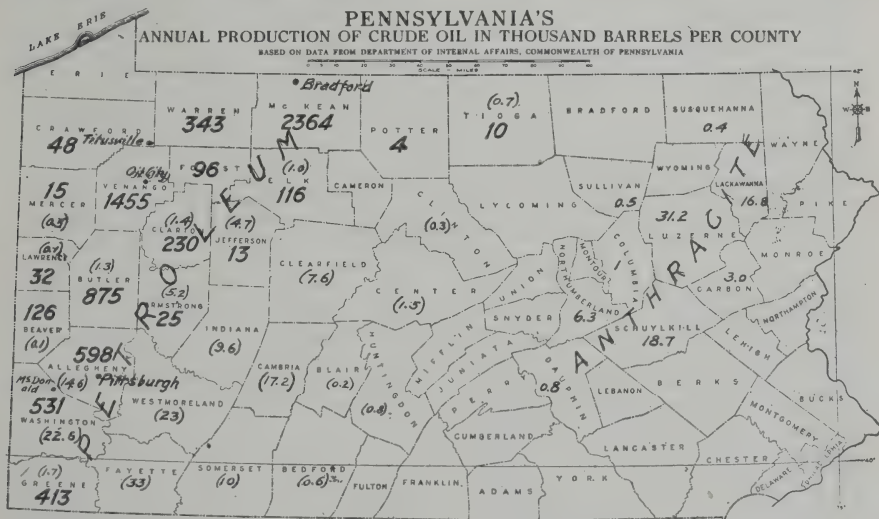


—The Oil & Gas Journal.

TYPICAL TOPOGRAPHY OF THE TEXAS PANHANDLE

Development in 1926 was so accelerated that daily yield reached 167,000 bbls. during a November week. Hutchinson County has contributed over 90 percent to the output of the Panhandle, the leading American field at the end of 1926.

Texas Temporarily Takes First Place. A prophecy of F. Julius Fohs has come to pass. During the Fall of 1926, in different weeks, Texas led California in daily production. According to *The Oil and Gas Journal*, the average daily during the week ended October 16 was 615,000 bbls. for Texas and 608,000 bbls. for California. On Tuesday, October 9, the Oklahoma output reached 508,000 bbls., the first time that it had passed the half-million mark since December 20, 1924. Late in 1926, the approximate order of the 11 leading fields in the United States was as follows: Hutchinson County, Tex., Panhandle; Smackover, Ark.; Seminole, Okla.; Long Beach, Calif.; Midway-Sunset, Calif.; Spindle Top, Tex.; Huntington Beach, Calif.; Ventura, Calif.; Burbank, Okla.; Santa Fe Springs, Calif.; Salt Creek, Wyo. Their daily rate ranged from 45,000 to 150,000 bbls.



The data shown here are for the year 1920. (Figures in parenthesis show million tons Bituminous Coal produced in 1920)

PENNSYLVANIA, THE PIONEER STATE IN AMERICAN PETROLEUM.

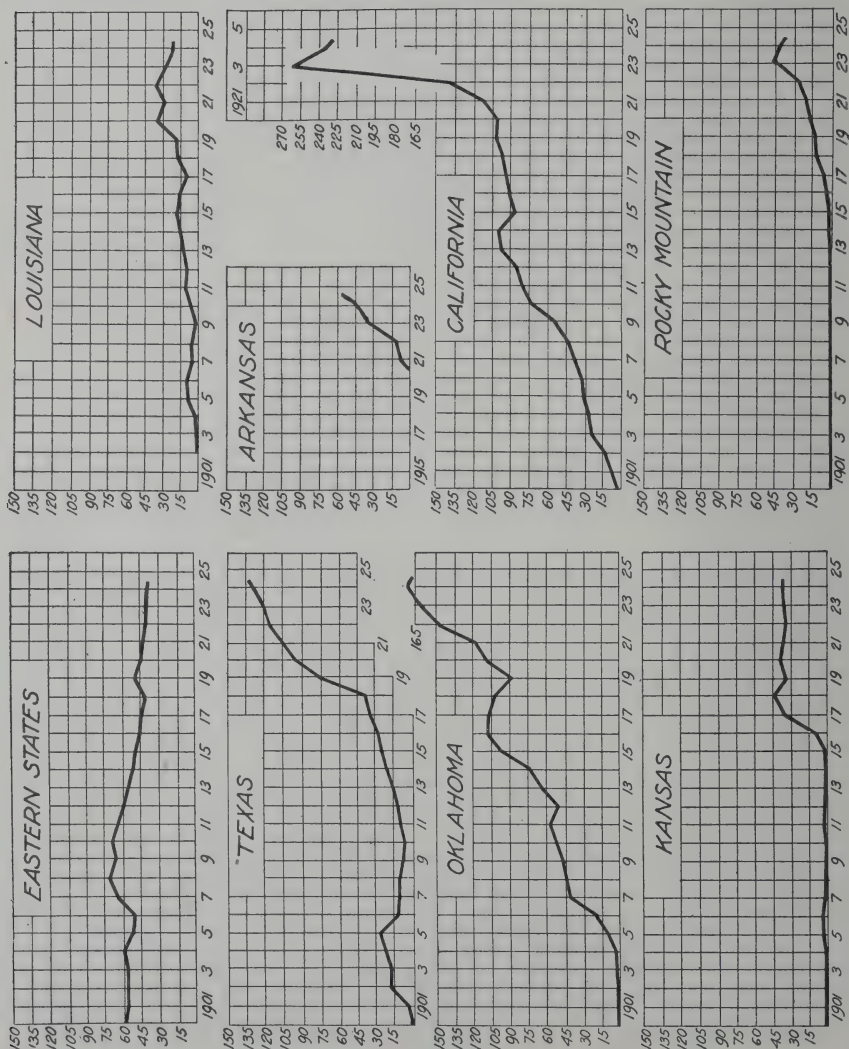
In 66 years has produced more crude of Pennsylvania grade than all other (Appalachian) states—almost 800 million barrels, and believed yet to have reserves of 600 million more recoverable by modern methods. Much of this excellent grade is still being sold below cost. Production rate remarkably settled, around $7\frac{1}{2}$ to 8 million bbls. since 1911, now making 1.2 percent of the nation's annual yield and giving the "Keystone State" eighth place in 1926: among all oil states and first among those east of the Mississippi. This state is distinguished further for: (1) its great number of live wells, nearly 80,000; (2) lowest average yield per well, hardly 0.3 barrels daily; (3) low hazard in drilling, only 13 percent dry during period 1914-1918 (when 10,889 wells were drilled); (4) long life of individual wells, some over 50 years (see Chap. XIII); (5) greatest mileage of pipe lines. During 1879-84 the Bradford pool was producing almost two-thirds of the world's petroleum; in 1926, through its rejuvenation, one-third of Pennsylvania's 9 million bbls. per annum. (The smaller figures not within parenthesis represent million tons of hard coal mined in each county, 1920.)



VENANGO COUNTY YIELDS ONE-SIXTH OF PENN. SYLVANIA'S OIL

This county, containing Oil City, ranks next to McKean, which contains the celebrated Bradford pool. The view is of "Big Injun" well, oldest producer in Venango County. It is on the Plummer farm, Bullion field, 2½ miles from Clintonville. Its initial yield, Sept., 1876, was 3,500 bbls. daily. Present rate is only two-thirds of a barrel. The pumping jack is shown between the Author at left, and Supt. Fleming, of the President Oil Co., Embleton.

—Texas Star.



Seven States Outrank Five Foreign Countries. Seven states west of the Mississippi produced together in 1925 almost three times as much as Mexico, Russia, Persia, the Dutch East Indies, and Venezuela combined. California contributed twice as much as Mexico and Louisiana just as little as Venezuela. Texas alone turned out of her wells last year 15,000,000 barrels more than all the five foreign producers named, except Mexico. The per capita output of these seven states far exceeds that of all the other oil-producing states, particularly those east of the Mississippi. Louisiana, the poorest of these seven, had a per capita yield three times that of West Virginia, the best eastern producer. The table below brings forth interesting facts about these seven American leaders in crude production compared with the five other states that produce about 6,000,000 barrels or more.

STATISTICAL DATA ABOUT THE 12 LEADING OIL STATES, 1925
(Area in thousand square miles, population and total production in millions)

State	Area	Popula- tion	Output, 1925	Per mile	Per capita	Output to Jan. 1, '26
California	158.3	4.0	230.2	1,454	57.6	2,300
Oklahoma	70.1	2.2	176.8	2,520	80.4	1,820
Texas	265.9	5.1	142.6	536	28.4	1,140
Arkansas	53.3	1.9	74.7	1,400	39.3	180
Kansas	82.2	1.8	38.3	466	21.3	344
Wyoming	97.9	0.23	29.2	300	127.0	200
Louisiana	48.5	1.9	20.0	412	10.5	311
Illinois	56.7	7.0	7.9	140	1.2	357
Pennsylvania	45.1	9.4	7.8	173	0.8	760
Ohio	41.0	6.5	7.2	175	1.1	515
Kentucky	40'6	2.5	6.8	166	2.7	76
West Virginia	24.2	1.6	5.8	239	3.6	344

Fifteen Foreign Countries Two-Fifths of Sixteen States, 1924-26. Even omitting the three leading American oil states with which no foreign countries compared in 1926, it may be seen from the following table that, beginning with Russia, practically every important oil nation could be approximately matched in crude output with one of the 13 other states listed in the table.

**CRUDE OIL PRODUCTION OF COUNTRIES AND STATES FOR THREE YEARS,
1924-1926, IN MILLIONS OF BARRELS OF 42 U. S. GALLONS**

Countries	1924	1925	1926 *	States	1924	1925	1926 *
United States	714	764	770	California	229	232	223
Mexico	140	115	88	Oklahoma	174	178	175
Russia	45	52	62	Texas	135	145	162
Venezuela	9	20	35	Arkansas	46	77.4	60
Persia	32	35	31	Kansas	29	38.4	42
Rumania	13	16.6	24	Wyoming	39.5	29.2	25
Dutch East Indies	20.5	21.5	22	Louisiana	21.1	20.2	22
Peru	7.8	9.2	11	Pennsylvania	7.5	7.9	8.8
India	8.1	8	8	Montana	2.8	4.1	8
Argentina	4.7	5.8	7	Illinois	8.1	7.9	7.8
Trinidad	4	5	6	Ohio	6.8	7.2	7.1
Poland	5.7	6	6	Kentucky	7.4	6.8	6.5
Colombia	0.5	0.6	5	West Virginia	5.9	5.8	5.9
British Borneo	4.2	4.3	4.3	Colorado .....	.4	1.2	2.7
Japan and Taiwan	2	2	1.9	New York	1.5	1.7	1.9
Egypt	1.1	1.2	1.3	New Mexico .....	.1	1.0	1.6

* Figures for foreign countries in 1926 are based upon estimates by V. R. Garfias, mgr., For. Oil Dept., H. L. Doherty & Co. Those for the states in 1926 are based upon preliminary 10-month total by (Miss) L. M. Jones and G. R. Hopkins, petroleum economist, Bur. of Mines. Combined output of Michigan, Tennessee and Alaska was less than 100,000 bbls. in 1926.

4. THE NUMBER OF WELLS AND THEIR DAILY YIELD, 1924-1925

A Plethora of Punctures Makes the Average Low. The average daily yield per well throughout the United States dropped from 6.7 barrels in

1923 to hardly 6.6 barrels in 1924. The reason was twofold: Decrease in total number of barrels produced from 735,000,000 in 1923 to 718,000,000 in 1924, and a slight increase in the number of wells producing, to practically 300,000. During January, 1925, the daily average of all the wells approximated 1,912,000 barrels, or 6.5 barrels per well. This rate per well seems insignificant in comparison with 375 barrels daily for each of almost 1,000 wells in Mexico (Chapter X). Slightly more than half of the wells in the United States averaged not quite 0.9 of a barrel daily during last January. In the three states of California, New Mexico, and Wyoming, the combined average was almost 47 barrels daily. Four American fields, Long Beach, Dominguez, Papoose and Wortham, with 800 wells altogether, averaged 410 barrels daily per well during January. In six states west of the Mississippi 28,136 wells averaged 45.6 barrels per well per day during the same month (January, 1925), making altogether 1,284,332 barrels or almost two-thirds of the total daily yield of the 298,831 wells.

NUMBER OF NEW AND TOTAL NUMBER OF OIL WELLS AND THEIR AVERAGE DAILY YIELD

State	New wells 1924	Total wells Jan., 1925	Daily rate Jan., 1925	Per well Jan., 1925
California	1,238	11,800	604,622	51.0
New Mexico	11	11	452	44.0
Arkansas	1,152	3,200	98,129	30.6
Wyoming	599	2,700	74,903	27.7
Texas	2,855	17,600	411,903	23.5
Montana	104	400	7,613	19.0
Colorado	4	80	1,774	22.2
Louisiana	170	3,300	53,677	16.3
Oklahoma	4,814	62,500	483,217	7.7
Kansas	650	17,200	77,194	4.5
Kentucky	1,176	12,200	18,571	1.52
Illinois	123	16,800	21,355	1.27
Indiana	114	2,600	2,290	.88
West Virginia	312	20,500	15,355	.75
Ohio	1,395	40,500	18,000	.44
Pennsylvania	1,564	73,200	19,516	.27
New York	287	14,200	3,806	.27
Tennessee	3	40	10	.25
Totals	16,571	298,831	1,912,387	6.53

Comparative Rates per Well per Day. The flush rate of yield in New Mexico makes ten times the more settled rate of Kansas. The fairly settled pumping output of Wyoming is exactly 100 times that of New York and Pennsylvania. Production of the much heavier Arkansas oil is proceeding 25 times as fast as that of the Illinois crude. Texas has a well rate three times that of Oklahoma or 30 times that of West Virginia.

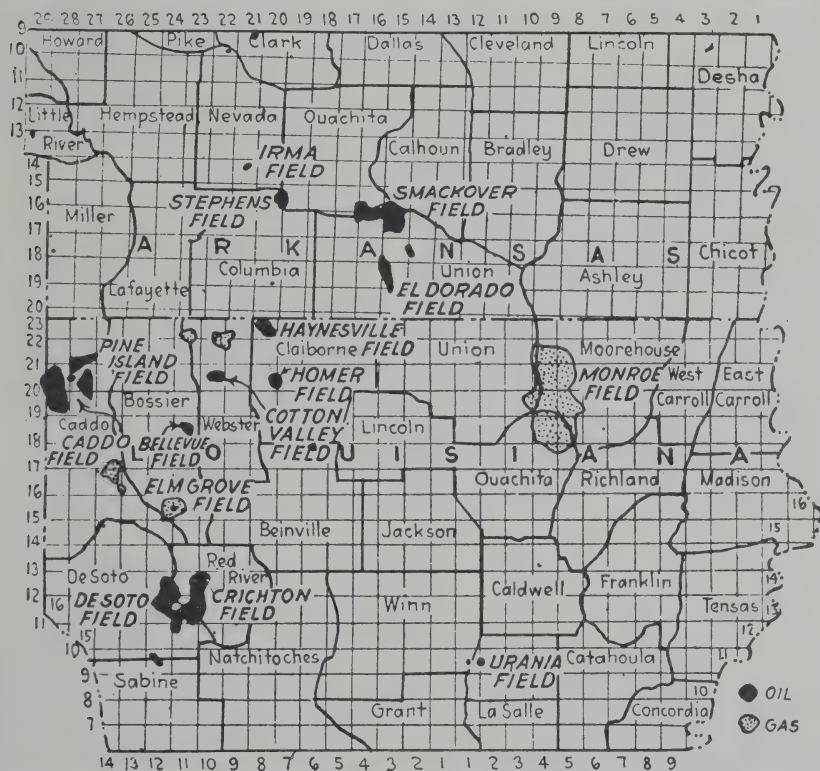
5. POSITION IN THE MINERAL INDUSTRY

How the Oil States Stand. From the table below it becomes clear that petroleum is a big factor in determining the rank of the leading states in the mineral industry. Among the first 10 only one is not an oil producer, namely the northernmost state which is noted for its enormous output of iron ore, 60 to 65 percent of the total for the United States. Among the next five but two are without oil wells, namely, Michigan which is second in iron ore and fourth in copper, and Arizona which is first in copper with usually 40 to 45 percent of the total. In the table the first percentage figure refers to the total value of \$6,000,000,000 for the mineral products of the United States in 1923—a total that was exceeded only in 1920, the year of high prices, when the amount was almost \$7,000,000,000. The second column gives the percentage of the total value of the crude oil,

\$930,000,000, for the same year, 1923, the latest for which the U. S. Geological Survey shows the derivation by states (see page 63).*

State	Percent of total	Percent of oil	State	Percent of total	Percent of oil
Pennsylvania	19.91	2.72	Minnesota	2.70	nil
Oklahoma	8.92	30.10	Indiana	2.62	0.20
West Virginia	8.68	2.17	Kansas	2.51	4.80
California	6.85	21.10	Michigan	2.45	nil
Texas	6.04	20.90	Louisiana	1.83	3.90
Illinois	5.92	1.75	New York	1.78	0.45
Ohio	5.73	1.83	Arizona	1.54	nil
Kentucky	3.84	1.71			

Importance of Petroleum in the Individual States. The position of the petroleum industry in the entire country has been indicated on pages 19-21, 61-63, and 82-83. To some states, especially those without coal resources



SOUTH ARKANSAS AND NORTH LOUISIANA IN 1926 PRODUCING AT ANNUAL RATE OF 80,000,000 BARRELS FROM SANDS OF UPPER CRETACEOUS AGE

Smackover has been the leading field of the United States since April, 1925. In June, 1926, its daily rate surpassed that of Long Beach (Calif.) by fully 40,000 barrels. In the last week of May, 1925, Smackover boosted the national yield to a peak of 2,347,000 barrels daily. Its production of over 431,000 barrels average daily for the week ended May 16, 1925, has been exceeded by only one other field, the Toteco-Cerro Azul in Mexico, which made 516,000 barrels on December 22, 1921. No state or nation in the first five years of its oil development has produced as much (180 million barrels) as Arkansas.

Urania, 50 miles south of the great Monroe gas field, became the prominent pool in Louisiana by the middle of 1926, leaving behind Caddo, Haynesville and Cotton Valley.

* Since this was written Michigan has become a producer. After 200 tests had been drilled at various times and places, oil was found commercially on the outskirts of Saginaw late in 1925. Early in April, 1926, five wells were together yielding 76 barrels daily, just before the Sun Oil Co. brought in a sixth well, apparently the best. See *The Oil and Gas Jnl.*, April 8, 1926; also in issue of April 1, "Michigan's Chance for Com'l Oil."

of consequence or without much development of other mineral deposits, oil, gas, and their dependent industries have become indispensable and of relatively greater importance than to the nation at large. Herewith are tabulated data about the petroleum states to show the places which oil, gas and natural gasoline occupy in the mineral industry. Other interesting comparisons could be made to bring out the relations to agriculture, transportation, per capita wealth, and consumption of petroleum products.

Rank in value*	Petroleum producing states in 1923	Millions of dollars			Mineral products in order of their values at mine, mill, quarry or well
		Crude oil	Natural gas	Natural gasoline	
1	Oklahoma	\$280.0	\$18.3	\$23.0	Oil, gas, natural gasoline, zinc, coal
2	California	196.0	8.5	16.6	Oil, cement, gas, clay products, gold
3	Texas	194.0	3.8	14.8	Oil, sulphur, natural gasoline, gas, cement
4	Pennsylvania	25.3	25.9	2.6	Coal, cement, clay products, gas, oil
5	West Virginia	20.2	24.4	8.9	Coal, gas, oil, clay products, natural gasoline
6	Wyoming	48.9	1.4	2.0	Oil, coal, gas, natural gasoline, gypsum
7	Kansas	46.0	2.7	.7	Oil, coal, gas, cement, zinc, salt
8	Louisiana	36.5	2.9	3.5	Oil, sulphur, gas, natural gasoline, salt
9	Arkansas	25.4	1.0	1.9	Oil, coal, gas, bauxite, clay products
10	Ohio	17.1	8.4	1.4	Coal, clay products, gas, oil, stone, lime
11	Kentucky	15.9	1.0	1.1	Coal, oil, clay products, gas, stone
12	Illinois	16.3	.6	.9	Coal, clay products, oil, cement, stone
13	New York	4.1	1.7	.04	Clay products, cement, gypsum, oil, stone, salt, sand and gravel, gas
14	Montana	4.0	.06	.....	Copper, silver, coal, zinc, oil, gold
15	Indiana	1.9	.3	nil	Coal, cement, clay products, stone, sand and gravel, oil, lime, gas

*Rank in combined values of the three natural petroleum products. Other producers in 1923 were Alaska, Colorado, Missouri, and Tennessee, but their aggregate output was insignificant—little more than 100,000 barrels. New Mexico became a producer during 1924, yielding high grade oil from the Hogback and Rattlesnake domes on the Navajo Indian reservation. California has improved its rank in value of oil and all minerals since 1923.

A SYNOPTICAL STORY OF PROMINENT STATES

THE STATE SUPREME IN CRUDE PRODUCTION

California Leads All Foreign Lands. No outsider, not even Mexico at its maximum in 1921, ever produced as much mineral oil in one year as California did in either 1923 or 1924. This state contributed 25.8 percent to the world output of petroleum in 1923, and 23 percent in 1924. California's peak of practically 263,000,000 barrels in 1923 was about the same as the production of the United States in 1914 or 70,000,000 more than Mexico's maximum. It was over three times as great as Russia's peak yield of 85,000,000 barrels in 1901, or almost six times its yield of 45,000,000 in 1924.

Enormous Drop Towards Normal Rate. A loss of 30,000,000 barrels in a year would mean a tremendous shock to any country or any state; but in the case of California this decline from the 1923 production made but 11.8 percent. The absolute decrease was not much less than the peak production of Pennsylvania (reached in 1891), that of Illinois (1908), or that of Louisiana (1920). During 1925 there may be another drop in the settled production, which from January to April was about 600,000 barrels daily or nearly 70 percent of the peak average of 872,000 barrels attained for the week ended August 18, 1923. Due to the development of Inglewood the daily yield was boosted to 670,000 barrels before the end of July, 1925.

Exceptional Concentration in California. In no other important oil state except Arkansas and Wyoming is the principal production of crude oil so



**SCENES FROM THE "SUNSET"
STATE—THE OLD AND
THE NEW IN OIL**

Site of the first well in California, drilled 140 feet with spring pole, 1869. First producer completed in 1875, also in Pico Canyon where the early Padres obtained tar from seepages. Production of oil in 1876 was only 12,000 barrels for the entire state, increasing 100-fold by 1895 and 10,000-fold by 1921.

—Courtesy of The Lamp.



Ventura (Ave.) field, near the Pacific, 40 miles west of Pico Canyon. A late well in May, 1926, came in at 5,600 feet with 2,600 barrels of 30° oil. By middle June daily output averaged 46,000 barrels of which Shell Union had 54 percent, Associated 40 percent, and General Petroleum (Stand., N. Y.), 6 percent. Daily rate, December, 1926, was 60,000 bbls.



Oil among oranges at Santa Fe Springs, which in its 6th year was yielding 50,000 barrels daily or 45 percent as much as Signal Hill (at Long Beach).

What is left of Lakeview's sand and cement dam built in 1910 when this famous well flowed 65,000 barrels daily. (In Midway-Sunset field.)



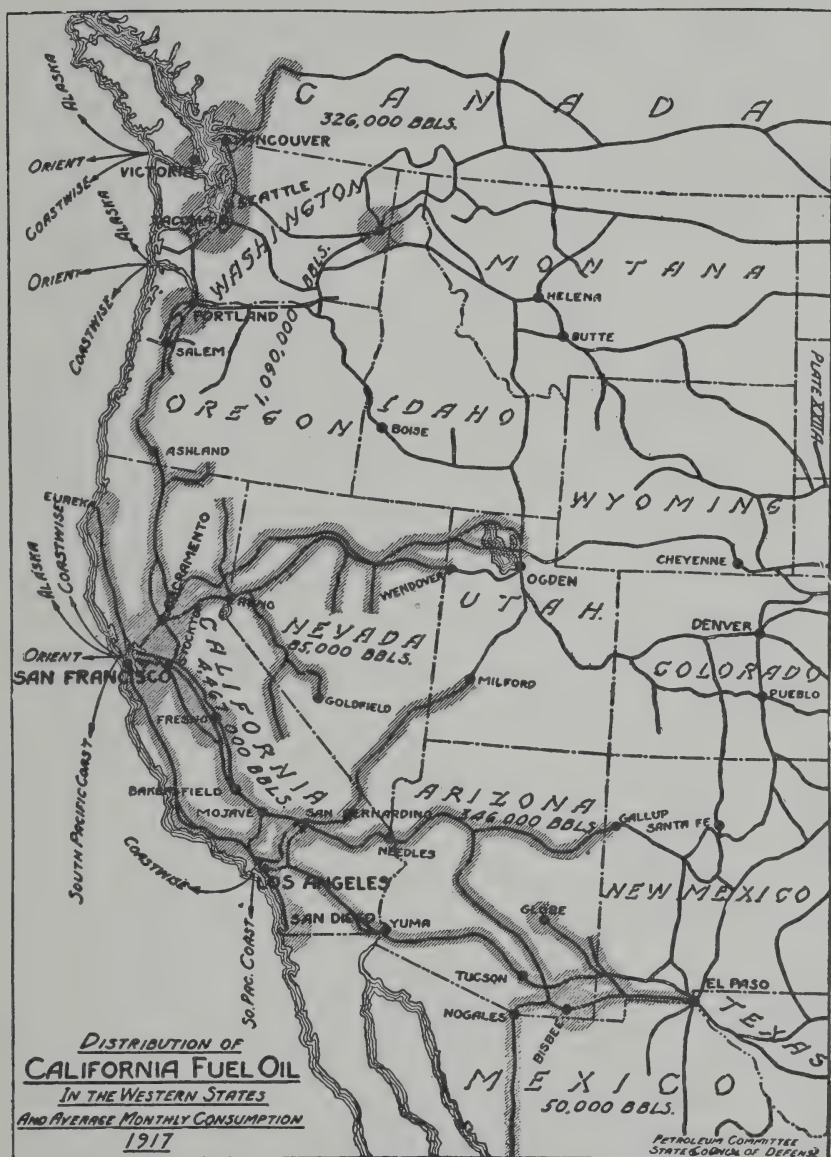
closely confined to small areas.* Out of a total area of 117,000 acres or 182 sq. miles in 1925, proven oil land in Kern County has 62 percent; Fresno County, 12.5 percent; Los Angeles County, 7.3 percent; and Orange County, 6.2 percent (see page 39). The two last named counties, with hardly 25 square miles of proven territory crowded into the southern part of the one and into the northwestern half of the other (page 35), controlled 78 percent or over 205,000,000 barrels of the California production in 1923. If to this be added the 46,000,000 that came out of Kern County, it will be found that 95.5 percent of the state's yield in that year is credited to three counties. In other words, three American counties have lately been contributing 31 to 34 percent of the domestic production of petroleum and from 20 to 22 percent of the world output!

Position of Petroleum in the Sunset State. California is a commonwealth of its own in practical independence of the rest of the country at least in respect to natural resources. No other state compares with it in varieties of climate, vegetation, animal life, natural scenery, and products whether of the sea, soil, or subsurface. It usually leads in at least 11 mineral products: Asphalt, borates, chromite, diatomaceous earth, gold, magnesite, oil (quantity only), platinum, potash, pyrite, and quicksilver. It is second in cement, lithium minerals, marl and peat; and third in crystalline graphite, manganese ore, natural gasoline and petroleum, considering the values of the minerals at the places of production. California is also an important producer of clay products, copper, salt, silver and stone although not ranking among the first five states in any of them. It is, however, fourth in the value of natural gas, and third in its volume (1923). The value of the state's production of oil, gas and natural gasoline in 1923 totaled \$221,000,000, which must have made considerably more than half of the value of all its mineral products for that year.

Petroleum Most Vital to California.† While the combined value of the three natural petroleum products may not make up quite so large a percentage of the total value of minerals produced in each of such states as Arkansas, Kansas, Oklahoma, Texas, and Wyoming, petroleum does mean a great deal more to California's industrial life than it does to that life in any other state. Although well endowed with water power this state is nearly as deficient in coal deposits as New York and New England. Natural reservoirs are not numerous and it takes time to build dams. Meanwhile, without cheap fuel California could not have reached her high degree of development and now harbor 4,000,000 inhabitants. In the course of thirty years mines, mills, smelters, factories, public utilities and railways west of the Rockies as well as ships on the Pacific have become dependent upon California fuel oil for much or all of their energy sources (see map). Mainly for such purposes was the great bulk of California oil adapted until the recent discoveries of lighter oils rich in gasoline content. With the exception pictured on page 112, this state has been self-sustaining in regard to motor fuel notwithstanding its almost perfect motor saturation. On January 1, 1925, California had registered nearly as many

* California's total to the end of 1924, 2,092 million barrels, surpassed Russia's corresponding total by almost 50 million barrels. Kern County alone has produced 100 million barrels more than Pennsylvania and New York together. The Midway-Sunset field within this county has contributed as much oil as all the pools of the Gulf Coast region of Texas.

† Without oil this state would not rank fourth in value of mineral products but would fall below Kansas and Michigan, displacing Louisiana for thirteenth place.



THE GEOGRAPHIC SIGNIFICANCE OF CALIFORNIA FUEL OIL

This map shows the territory supplied with California fuel oil a few years ago. Since then, as indicated on pages 97-99, fuel oil has violently invaded the markets of the world in competition with coal. One reason is found in the greater radius of navigation provided a vessel without re-fuelling. Fuel oil stations are now widely scattered along international channels of trade. They get their supplies mainly from Mexico, California, and the Gulf coast of Texas. Said Robert Newton Lynch, vice president of the San Francisco Chamber of Commerce, in May, 1924, at Washington: "The vast output of oil in California means that our Pacific ships have practically all been converted to oil burners. This cheap fuel also supplies railroads of the West, having almost entirely eliminated coal. At present prices a barrel of oil is equal to a quarter of a ton of coal, and counting coal at \$10 a ton, a dollar's worth of oil will go as far as \$2.23 worth of coal. Even at that, great bodies of coal are present in Utah and Wyoming, and there are high grade deposits in Alaska, besides minor deposits in Washington, Oregon and California." (In 1926 the Great Northern Ry. contracted for $3\frac{1}{2}$ million bbls. yearly of Sunburst, Mont., fuel oil.)

motor vehicles as New York and boasted one car or truck for every three persons (page . .). This is more than twice the average degree of motor saturation, 6.4 persons per vehicle, for the whole United States.

Economic Evolution and Emergence from Isolation. California's oil industry was born in 1876, simultaneously with the first but larger production in Ohio and West Virginia. From only 12,000 barrels in that year the yield increased to almost 700,000 in 1888. The annual rate then dropped notwithstanding the introduction of fuel oil for locomotive firing. It took time to design and perfect oil-burners, to prove the economy and efficiency of fuel oil, and to overcome objections to its use in place of coal such as doubt as to the capacity and permanency of the supply. From 1,200,000 barrels in 1895 the annual output advanced steadily to almost 100,000,000 barrels in 1914. From 86,000,000 in 1915 production gained slowly to 112,600,000 barrels in 1921. An output of 138,500,000 barrels in 1922 permitted California's influence to be felt for the first time east of the Rockies (pages 21 and 78-79). The Mid Continent producers, much more than others, suffered from the competition with Pacific coast oil in 1923 and 1924. An increase of 125,000,000 barrels in one year, unheard of before in the annals of oildom, could not happen without harmful effects whether from the standpoint of economic waste or corporate profits. Tanker transport through the Panama Canal permitted the dumping of distress crude and gasoline along the Atlantic at less cost than if pumped through pipe lines from the Mid Continent. Mitigating that evil, however, is the growing demand of joy riders in California and the decrease in daily output to only twice the normal of almost 300,000 during the decade prior to 1922.*

New Development in 1924 and Early 1925. Nothing of a sensational nature happened in California in the course of 1924. In daily output southern California fell off 166,000 barrels between January 5, 1924 and January 3, 1925, making a decrease from 70 percent of the state's total to 53 percent in the course of twelve months. The rate for the whole state

* An excellent economic article, "California's Part in Present Situation," by Charles E. Bowles in *The Oil and Gas Journal*, September 11, 1924, voices the views of the Mid-Continent interests which were so adversely affected by the flood of oil from southern California during the past two years. See also "Sunkist Oil for Eastern Seaboard" in *The Lamp*, house organ of the Standard of N. J., December, 1922.

Read "California's Effect on the Export Trade," by L. M. Fanning, June 5, 1924, and "California Again a Menace to Oil Market," by N. O. Fanning, in *The Oil and Gas Journal*, March 19, 1925. Following are excerpts from an address delivered in December, 1924, at the Fort Worth meeting of the American Petroleum Institute by D. M. Folsom, of the General Petroleum Corporation:

"The Pacific Coast, from the standpoint of fuel, has always appeared as an isolated province with California oil the principal source of heat, light and power, over a wide territory. * * * Three years ago we expected the output to climb to 400,000 barrels a day (it actually approximated 1,000,000 barrels potential at one time in August, 1923). * * * In the three years from January 1, 1922, to January 1, 1925, California produced a total of 634,000,000 barrels (an annual average of over 211,000,000). The markets on the shores of the Pacific have been expanded by both normal growth of business and deliveries into new territory. The use of oil in the area normally and properly supplied by California has grown from 300,000 to 500,000 barrels a day. California companies also sold and shipped in the last two years to Atlantic and trans-Atlantic markets not previously supplied by them an average of 150,000 barrels daily or a total of over 100,000,000. In other words, our sales for the past three years totaled 562,000,000 barrels, 20 percent of which was surplus sold in direct competition with the output from Mid Continent, Gulf Coast and Eastern fields. During this time the "Sunset State" emerged from a position of isolation and became an integral part of a world-wide industry."

CALIFORNIA POOLS, 1926
Average Daily Rate During First Week of
December

	Number of wells	Thous. bbls.
Long Beach	747	97
Midway-Sunset	2,998	93
Huntington Beach	412	85
Ventura Avenue	73	60
Santa Fe Springs	338	45
Inglewood (below)	204	40
Elk Hills	—	—
Torrance	659	26
Dominguez	76	21
Coalinga, Fullerton	—	—
Montebello, Coyote	—	—
Rosecrans (at left)	140	14.5
Kern River, Santa Maria....	—	—
Seal Beach (Los A. County) .	5	10



(AT LEFT) ROSECRANS POOL OF VERY LIGHT OIL.—Note the California type of steel derrick with safety scaffold, made by the International Derrick and Equipment Co.

dropped 13 percent—from 700,000 to 607,000. The ebbing was arrested somewhat by the reopening of old or shut-in wells in the San Joaquin valley, the drilling of new wells in the Elk Hills field, the deepening of other wells, the opening up of the Rosecrans pool southwest of Los Angeles, and the continued development of the nearby Compton or Dominguez (page 20). The last named produced 6.8 million barrels, or more in its first full calendar year (1924) than any of such older fields as Kern River, Montebello, Sunset, Coyote, Richfield and Fullerton in the same year. Rosecrans is remarkable not for quantity but for quality. The first well came in late in October, 1924, with 410 barrels of 36.5 gravity oil from a total depth of 4,698 feet. Later wells ranged in depth from 4,520 to 4,781 feet, with oil as light as 42.8 degrees Baumé and yielding 40 to 50 percent gasoline. Its latest well was finished in March, 1925, as a pumper

THE NEW POOL AT
INGLEWOOD

Discovered late in 1924, this relatively shallow pool attained a peak above 110,000 barrels and an average of 52,000 daily during 1925. In July, 1925, it was temporarily second to Smackover (Ark.), and ahead of Signal Hill (Long Beach). At the middle of 1926 it ranked third in California with a daily rate of 50,000 bbls.; in Dec., 6th, with 40,000. The oil is heavier than the average produced in the Los Angeles Basin.



good for 80 barrels from a depth of 6,737 feet. It was then *the deepest oil well in the world*. New additions are the shallow Culver City area of the Baldwin Hills-Inglewood district which was producing at the daily rate of about 2,500 barrels from 10 wells on March 21, 1925,[†] and the deep Buena Vista valley pool between Elk Hills and Midway-Sunset where a 1,600-barrel well was brought in about the same time.[‡] At the middle of 1925 the Inglewood pool had a daily rate approaching 90,000 barrels, making it fourth in the United States. This rank Inglewood held even before its rejuvenation in the spring of 1926.

Whence the Current Production Comes. In 1920 only 36 percent of the production came from pools of light oil located mainly in the Los Angeles Basin; in 1921, 44 percent; in 1922, 63 percent; and in 1923, 80 percent. In 1924 it is estimated that no more than 68 percent of the 232,000,000 barrels was obtained from light-oil pools. In the table below the daily average (in thousands of barrels) is indicated for a late week in 1925.

Long Beach.....	113	Torrance	32	Coyote	13
Midway-Sunset	100	Elk Hills.....	27	Fullerton	15.3
Inglewood	69	Dominguez	26	Kern River.....	12.4
Santa Fe Spgs.....	53	Rosecrans	25.5	Richfield	11.5
Huntington B.....	44	Coalinga	19.6		
Ventura-N'hall	37	Montebello	19		

Los Angeles Basin the Leading Source in 1925. Herewith is tabulated important facts about the seven foremost fields of southern California, including the total production to January 1, 1926, and the production in 1924 and 1925, expressed in *millions* of barrels. Noteworthy are the high yields per acre and per well.

Field or pool	Year found	Production		To Jan. 1, '26	No. of wells	Acreage proven	Yield per acre
		1924	1925				
Long Beach.....	1921	60.1	40.1	187.7	620	1,250	142,150
Santa Fe Springs.....	1921	26.4	19.1	136.5	350	1,570	86,973
Huntington Beach.....	1920	17.5	15.9	81.5	335	2,290	35,600
Torrance	1922	17.5	13.3	34.1	603	3,550	9,600
Dominguez	1923	6.8	33.4	20.4	62	870	25,000
Inglewood	1924	.01	19.0	19.0	171	850	22,406
Rosecrans	1924	.6	7.4	8.0	113	400	20,000
Totals.....		128.9	128.2	487.2	2,254	10,780	45,200

Inclusive of the other "pools" (page 35), the Los Angeles Basin contributed about two-thirds of California's total output of over 230,000,000 barrels in 1925. Despite a sudden drop of 10,000 barrels in daily yield, the six fields listed above were in April, 1925, supplying about 55 percent of the state's total, which in four years has stayed above the 600,000 mark.*

Resume of California's Remarkable Record. Beginning a half century ago, 16 years after the Drake discovery, or 27 years after the Marshall gold discovery, California has produced more petroleum than Russia and in one-fifth less time. It now leads all foreign lands, not one of which in a single year has come within 70,000,000 barrels of winning as much as this state did in 1923. On one day of that year 10,000 California wells were able to produce 1,000,000 barrels. All in all, the oil fields of the

[†] Discovered by the Standard Oil Company (California) at 2,136 feet, September, 1924; initial yield 160 barrels; located about 9 miles west of Los Angeles. In the fall of 1925 the Amestoy was superseded by the Athens No. 6 of the Miley Oil Co., also in the Rosecrans field, but 854 feet deeper, as the deepest producer.

[‡] By the Pacific Oil Company, in section 19, 31-24, at 4,000 feet.

* Read "California's Wonder Pools," *Barron's*, Feb. 22, 1926, and "Less California Oil," *Wall St. Jnl.*, April 13, 1926.

"Sunkist State" are even more marvelous than those of Mexico. Its asphalt beds have preserved the bones of more than 10,000 extinct animals on less than 20 acres of one field alone (see page 29). Among its other wonders of the oil world are the tremendous thicknesses of the oil bearing horizons, up to 2,000 feet in a single field, thus insuring long life of productivity. Consistent with California's surprising variety in physical features and natural resources, a great range is found in the depth and quality of the petroleum deposits (page 35). Oil now comes from a well in the Rosecrans pool 6,737 feet deep, the *deepest producer* in the world. The state produces more per acre and more per well than any other state (pages 39 and 48). Best of all, it is believed to have the biggest reserves of any state, more than two-fifths as much as the unmined oil of all the five Mid Continent states, including that of the Gulf Coast region (page 39). Tourists of the twenty-first century may yet motor amidst the scenic splendors of California provided the wastefulness of present joy riders be reduced, for a limit there is on the potential supply of petroleum, the elusive liquid! (See index under "California," "Kern County," and especially "Los Angeles.")

2. OKLAHOMA, HOME OF CUSHING AND HEART OF MID-CONTINENT

Oklahoma Outranks California in Value, Not Volume.* Owing to its much greater content of gasoline and lubricating fractions, Oklahoma oils bring so much better prices than most of the California oils as to place the former in first rank in respect to value. In 1920, when Mid Continent crude sold at \$3.50—the nearest it has ever come to its true value—the output of Oklahoma's 53,000 wells was worth \$356,400,000—the greatest value for any state for any year, and 26 percent of the total for the United States in that year. The average annual value for the nine leading states during the seven years 1917-1923 is given below for purpose of comparison.

State	Million dollars	Per cent	State	Million dollars	Per cent
Oklahoma	\$238.1	28	West Virginia.....	\$30.5	3.6
Texas	161.8	18.9	Pennsylvania.....	29.6	3.5
California	159.4	18.7	Wyoming	29.3	3.4
Kansas	76.4	8.9	Illinois	26.8	3.1
Louisiana	45.4	5.3			

Important Producer of Other Minerals. Oklahoma is not as large, varied or populous as California yet yields a variety of products from both soil and subsoil. The state stands first not only in value of petroleum but also in quantity and value of natural gasoline and of zinc. It ranks third in natural gas and in diatomaceous earth (including tripoli). It is surpassed by Pennsylvania alone in the annual value of all mineral products. In

* A rhymster once wrote, "Of cattle and cotton great Texas is full, of oil Oklahoma, Wyoming of wool." This seems literally true according to a recent map of the state's oil and gas regions. Production is now obtained from five times as many counties as in California and these are more widely scattered, one of them, Beckham county, being situated next to the Texas Panhandle. The big bulk of the oil, especially the high grade or light oil, is derived from a domain centering around southern Osage County and not far northwest of Tulsa. As the California output diminishes, the national center of petroleum production will likely return from Texas into southwestern Oklahoma.

Outside of Oklahoma few persons realize that this state has stood first in both volume and value of petroleum since the World War began with only four exceptions. California was foremost in quantity during these ten years only in 1919, 1923, 1924, and 1925, and will probably retain such rank for some time since its rate of yield is fairly settled and no startling developments are looked for in Oklahoma.

recent years it has risen to fourth place in lead, which with the zinc; is mined from limestone beds in the northeastern corner of the state. Oklahoma is either fifth or sixth in gypsum, a product of the Red Beds in the central-southern part of the state. From the thirteenth in coal during 1913, the state had dropped to twentieth rank in 1923. Labor troubles and use of liquid fuel account for the decline in coal mining. While the southeastern quarter of the state contains most of the coal mines, the northeastern has most of the oil wells.

Comparative Production of Natural Gasoline. In 1923, as in 1922, Oklahoma was far ahead of any other state in the quantity and value of gasoline recovered from natural gas. Out of a little more than 1,000,000,000 M cubic feet of all natural gas produced in the United States in 1923, about 87 percent was treated for the content of gasoline vapor; but in this state about 97 percent of the output was so treated. For the whole country the percentage has increased from 2 in 1913 to 62 in 1918 and 72 in 1922. Oklahoma's leadership in this practical form of conservation is plainly shown in the table below. The values given are at the plants near the oil or gas wells (pages 108-109). Both quantity and value of the raw or unblended motor fuel are expressed respectively in millions of gallons and millions of dollars, for 1923.

State	Quantity	Value	Percent	State	Quantity	Value	Percent
Oklahoma	270.2	\$23.0	29.8	Wyoming	21.3	\$2.0	2.6
Texas	177.8	14.8	19.1	Pennsylvania	19.1	2.6	3.3
California	173.3	16.6	20.3	Arkansas	16.2	1.9	2.5
West Virginia	63.4	8.9	11.5	Ohio	10.0	1.45	1.9
Louisiana	40.7	3.5	4.5	Kentucky*	7.6	1.07	1.3

Kansas produced a little more than Kentucky, namely 8.8 million gallons, but it was worth not quite \$700,000. Illinois was the 11th state in value of natural gasoline recovered—about \$850,000—but ranked only 12th in quantity. New York produced less than one-twentieth as much as Kansas. Data derived from U. S. Geological Survey press bulletin dated November 21, 1924.

SUMMARY NATURAL GASOLINE PLANTS, 1925

(Daily capacity in thousands of ~~barrels~~ *gals.*)

States	Total plants Aug. 1, 1925	Total capacity Aug. 1, 1925	Total plants 1924	Total capacity 1924	Plants operating Aug. 1, 1925
Arkansas	12	82.5	8	50.5	9
Kansas	23	121.7	15	64.9	18
*Louisiana	56	177.2	35	130.4	44
Oklahoma	352	1,525.8	340	1,356.6	315
*Texas	157	1,026.7	149	876.2	146
Mid-Continent	600	2,933.9	547	2,478.6	532
California	162	1,227.8	108	600.7	142
Illinois	125	40.0	10	2.1	122
Indiana	1	.3	.....	.....	1
Kentucky	11	19.7	10	8.6	10
New York	1	.5	.....	.....	1
Ohio	29	13.3	52	14.9	29
Pennsylvania	96	47.7	121	68.2	94
South Carolina	1	2.0	.....	.....	...
West Virginia	108	124.6	148	130.3	105
Wyoming	10	84.5	16	93.6	7
Subtotal	544	1,560.4	465	918.4	511
Grand total	1,144	4,494.3	1,012	3,397.0	1,043

* No plants out of Mid-Continent. The Oil and Gas Journal, Aug. 18, 1925.

Glenn Pool the First Great Discovery. The incentive for early exploration in the old Indian Territory came from Kansas. Oil was there dis-



A FAMOUS FUEL STATE IS WEST VIRGINIA

It has usually stood second in value among the mining states. Recently it rose to second rank in coal production. It was second in petroleum in 1900 and 1901, but lately dropped to twelfth with the discouragement due to the low price of crude. Wyoming and Kentucky are probably the only other states in which fuels contribute 90 percent or more to the total value of the mineral yield. West Virginia is particularly noted for the lubricating content of its crude oil and the smokeless quality of the coal from the Pocahontas and other fields.

NATURAL GAS IN THE UNITED STATES AND WEST VIRGINIA

In 1924 over 1,141 billion cubic feet of natural gas was consumed, double as much as in 1914. It was worth \$105,800,000 at the wells and \$253,800,000 at consuming points. Leading producers were: Okla. (314.5 bil. ft.), Calif (189.7), W. Va. (182.3), La., Tex., Pa., Ohio, Wyo., Ark., and Kan. In 1923 West Virginia still led in value although tied with Oklahoma in quantity (204 bil.). The former had held first rank since 1909. In 1924 Pennsylvania also fell off, from fourth to sixth. Natural gas for households was cheapest in West Virginia in 1924, only 29.6 cents per thousand, compared with 91.2 cents in Missouri. The percentage of the total volume treated for extraction of gasoline was 89 in 1924, 87 in 1923, 71.5 in 1922, and 62.2 in 1920, according to the Bureau of Mines. (The well shown at the right had a closed pressure of 925 pounds per square inch in 1925. It belongs to the Barbour County Natural Gas Co., operating in West Virginia.)



covered by the drill in the early eighties although actual production did not begin before 1889 or two years ahead of production in what is now Oklahoma. For 10 years the Oklahoma output was trivial, not reaching 10,000 barrels annually until 1901.* In 1905 the Bartlesville-Dewey pool was opened. On November 22 of the same year the first well of the great Glenn pool came in for only 85 barrels at 1,481 feet. This pool's daily yield increased during 1907 from 12,500 barrels in January to 82,000 in October. It caused the Gulf and Texas companies to build pipe lines to the Gulf Coast from eastern Creek County in Oklahoma. On March 12, at 1,450 feet, Cushing came into existence and eventually graduated into the world's greatest light gravity oil field (page 42). This district also in Creek County, has several divisions, including the Drumright and Shamrock, and covers an area of about 203,000 acres or over 335 square miles. In total output to the end of 1924, Cushing is surpassed (in the United States) by only one other field, the Midway-Sunset in California, thus ranking ahead of Coalinga (Calif.), Bradford (Pa.), and Kern River (Calif.), each of which has contributed 250,000,000 barrels or more. The first important find in southern Oklahoma occurred in August, 1913, when relatively heavy oil (25 to 35 degrees B.) was found at Healdton. Nearby in the same County of Carter, the Hewitt pool of a little lighter oil was discovered, hardly six years later.

Burbank and Tonkawa Boost Output to the Half-Million Mark. The initial output of oil from the Osage Indian reservation dates from 1901, the year after the first real commercial discovery in the state was made when the Red Fork-Tulsa district was opened just off the southeast corner of this great reservation.† Eastern Osage was first developed, and the output rose from 10,500 in 1902 to 1,870,000 barrels in 1905. It was steady at about 5,000,000 barrels during the next five years, reaching a peak of about 11,100,000 in 1914 but dropping off 33 percent the next year. The 10,000,000 mark was again passed in 1918; but the big impetus to production did not come before the Burbank was found in the extreme western Osage. This discovery in May, 1920, at 2,965 feet, made by Marland, brought the yearly yield of Osage up to 17,000,000 barrels. Daily production climbed from 55,000 at the end of 1921 to the peak of 120,000 barrels in Burbank about the time the peak for the state was attained, or just before the peak of 2,320,000 barrels for the whole country was reached on July 14, 1923. (A record broken week ended May 29, 1925: 2,348,000 barrels. In week ended November 27, 1926: 2,380,000 bbls. average daily).

Similarly, Tonkawa (pages 32-33 and 70) has twice boosted the totals for the state and the entire country. This younger field is located about 30 miles southwest of Burbank and equally convenient to Ponca City. The Cosden and Marland companies jointly drilled the original discovery well in June, 1921, to 2,658 feet two miles south of the Kay-Noble county line. First peak was reached about June 1, 1923, at 112,000 barrels daily, bringing Oklahoma's output up to an average of 505,000 in May and 519,000 in June, 1923, which records were exceeded in August, 1924, when the state's

*In fact, before 1907 the yield was so insignificant that for statistical purposes the U. S. Geological Survey included it with the quantity credited to Kansas.

† Osage County or "Nation" is the largest subdivision of Oklahoma and in the course of 25 years has become literally dotted all over with derricks, making this the leader in the state. During the past five years it has produced 155,000,000 barrels or 15,000,000 more than Creek County; but in total to date the latter still leads with a credit of 530,000,000 barrels compared with 285,000,000 for Osage to the end of 1924.



**WEST TULSA—
OKLAHOMA'S
FOREMOST RE-
FINING CENTER**

Here, across the Cimarron from Tulsa proper, are located not only the great Cosden (now "Mid-Continent") plant but also a smaller refinery of The Texas Company.

—The Texaco Star.

average was almost 533,000 barrels daily. Second pool peak of about 108,000 barrels at the middle of September, resulted from the opening of the Wilcox sand, 4,065-4,087 feet deep, April, 1924, by that successful wildcatter, T. B. Slick.* The initial well was good for 3,000 barrels of high gravity oil. Rotaries were used for rapid development. The average daily for the state rose to 543,000 barrels in September, the highest level in its history, and staid above the half-million mark almost to the end of the year. Without this wonderful discovery at Tonkawa, rejuvenation through deep drilling, Oklahoma could not have eclipsed its achievement of 1923 through increasing the output over 10,000,000 barrels during 1924, while California was losing 30,000,000.

Prominent Pools. In the following table the twelve leading pools in Oklahoma are arranged in their order of importance for 1925. The Cromwell pool in northeastern Seminole County proved to be the most sensational in its development next to the Tonkawa deep. It was discovered by the Cosden Company in December, 1922, but lay dormant until March, 1924. Daily production jumped from 543 barrels in February to 61,000 in August after the new well came in at about 3,400 feet with 4,600 barrels of high gravity oil. The Seminole pool led in December, 1926, with 110,000 barrels.

Rank, 1925	Name of pool	Production (mil.)		Rank, 1925	Name of pool	Production (mil.)	
		To 1925	In 1924			To 1925	In 1924
1	Tonkawa	53.2	22.4	7	Hewitt	48.4	6.9
2	Burbank	95.0	30.8	8	Healdton	131.7	6.0
3	Bristow .....	...	14.7	9	Wewoka .....	...	11.5
4	Cromwell	10.4	10.3	10	Graham .....	...	10.4
3	Papoose (Wetumka) ..	3.6	3.5	11	Watchorn (Otoe)	1.2	1.2
6	Cushing	289.0	8.7	12	Glenn	174.0	3.6

Summary of Oklahoma's Situation in Oil. The very widespread oil industry of this state is unique in many ways. Relatively more people

* He is likely the largest individual operator in the Mid-Continent, having under lease more than 350,000 acres. See Chapter XII. First peak of Tonkawa Deep, 88,600 barrels, occurred in September, and the second of 89,400 came in December, 1924.

† Dixie Oil Co., according to *Wall Street Journal*, March 4, 1925.

therein are interested in the industry than in California.† In part this is proven by the higher per capita production of crude petroleum, 58 barrels in the latter and 78 barrels in Oklahoma during 1924. Only one other state, Wyoming, with just one-tenth the population of Oklahoma, excels in this respect, the per capita output there being 182 barrels last year. Only one other state, Pennsylvania, possesses more than 60,000 live wells. During the year 1920 alone 9,097 wells were drilled in this state, probably the greatest number of new wells for any state in a twelve-month period. During 1924 there were 4,814 wells drilled, about 200 more than in all Texas and 600 more than in all the territory east of the Mississippi. Oklahoma was the first to pass the 100,000,000 mark (in 1916) and also the 140,000,000 mark (in 1922). Although to date it has produced only three-fourths as much oil as California it has been the source of about 500,000,000 barrels more of light oil than any other state; and this has been sold at a sacrifice for the good of the whole country. Oklahoma contains two of the world's three greatest high gravity fields. It is the home of the opulent Osages who own one of these fields and who number about 2,250. This world's wealthiest tribe received for 1924 an income from oil probably exceeding \$20,000 for every papoose, squaw and buck! And they are not the only Red Skins in Oklahoma to enrich whom the white man has run all the risks!‡

TEXAS—A TREASURE VAULT OF PETROLEUM

Oil Story of the State With the Richest Reserves. It is not commonly known that Nacogdoches County in eastern Texas was the scene of the first petroleum development within the "Lone Star" state. Wells 150 to 200 feet deep were drilled there in the early '80s, and one flowed as high as 200 barrels a day but the field did not last very long. Texas became a more permanent source of petroleum in 1895 when the shallow Corsicana pool was opened in Navarro County. But the million mark in yearly yield was not reached until Spindle Top began to spout in Jefferson County (pages 40-41). In Hardin County, to the northwest of Beaumont, the opening of the Sour Lake and Saratoga pools later on in 1901-1902 marked the next steps in the growth of the Gulf Coast oil industry. In total output to 1925, Sour Lake ranks just below Humble, in Harris County, where a shallow sand above the salt dome was tapped in 1905, successful deep wells not being drilled before 1915. Goose Creek, also in Harris County, was developed between 1907 and 1912, deep sands being discovered in 1916. Fourth among Gulf pools in production to 1925, this one led Humble during 1918, and would have superseded Spindle Top in third place by now but for the progress made at West Columbia in Brazoria County. The startling development of the last named was deferred from 1918 until 1920 when the famous Abrams No. 1 of The Texas Company blew in, rating second in Texas oildom only to the great Lucas gusher at Spindle Top. Not all of the 40 or more salt domes have proven of commercial importance; but geologists generally concede that the largest re-

† According to the Census Bureau, in 1919 there were 21,180 wage earners employed in the oil and gas industry of Oklahoma, or 22.7 percent of the 93,205 in all the states. This was 63 percent more than in Texas, 71.5 percent more than in California, and 72 percent more than in West Virginia.

‡ For details see Chapter XII. For additional facts, about Oklahoma refer to index. Its pipe-line mileage of 17,384 in 1924 was 5,340 greater than that of Texas or 6,020 miles greater than that of Pennsylvania.

serves in Texas, probably more than 2,000 million barrels, are contained in the Gulf Coast fields. Outside of Louisiana they are credited with over 440,000,000 barrels produced up to 1925.*

North and Central Sections Now More Important. Honor for being the oldest pool in North Texas goes to Petrolia where, in Clay County, a well less than 800 feet deep was drilled in 1905. Later on large gas wells were brought in and now the Petrolia field is probably the world's greatest helium producer. Electra, in Wichita and Wilbarger counties, entered the limelight in 1911, and by 1925 had produced close to 70,000,000 barrels, one-tenth thereof in 1924. Burkburnett, one of the most spectacular fields found in Texas came into existence in 1912 but did not attain national prominence before the Townsite pool (page 72) was brought in six years later, followed quickly by the Northwest Extension and the Texhoma or Southeast Burkburnett. The entire field had produced 109,000,000 up to 1925; and Wichita County fully 182,000,000 barrels inclusive of the yield from the Electra, Iowa Park, and Kemp-Munger-Allen pools. Burkburnett is 15,000,000 ahead of Humble, and Wichita County (including a little oil from Wilbarger County) is 35,000,000 barrels above Harris County of the Gulf Coast. To Wichita County (or the Electra district) credit is due for starting Texas uphill after toboggoning from its first yearly peak of 28,136,000 barrels in 1905 to the bottom of 8,900,000 barrels in 1910; concurrently dropping from interstate rank next to California in 1905 to sixth, following Ohio in 1910.† A greater sensation than the much more voluminous Lucas gusher of the Gulf Coast came in 1917, when the Ranger or North Central district became commercially and nationally celebrated after the almost simultaneous discoveries in northern Eastland and central Stephens counties.‡ A little oil had already been coming from southeastern Shackelford and southwestern Palo Pinto counties (Moran field from 1914 and Strawn from 1915). As a result of the widespread wildcatting in the greater Ranger district, Texas took third place in 1919 with an output of almost 80,000,000 barrels, more than double the 38¾ million produced in 1918 (when Kansas stood third for the second time.) Production went to nearly 97,000,000 in 1920 or almost three times that of Kansas.

Prolific Production from the Mexia Fault Belt. The East Central or Mexia district was unknown for oil outside of the shallow Powell and Corsicana pools in Navarro county until Colonel Humphreys drilled into the Mexia-Groesback structure late in 1920. Development dragged along to September, 1921, when one of the biggest wells ever drilled in Texas came in for 18,000 barrels daily just west of the town of Mexia. Daily peak went up to 190,000 barrels early in 1922, and by March 1, or in less than six months, the Mexia pool had given up over 15.5 million barrels. Humphreys-Fohs activities were next devoted to the prodigious Powell field

* Writing in the *Wall Street Journal* of March 24, 1925, from San Antonio the great financial authority, C. W. Barron, called attention to the tremendous output per acre in some of the Gulf Coast fields. He regards Texas as a region of untold potentiality in oil. See pages 36 and 70.

† The four leading oil states in 1910 were California, Oklahoma, Illinois and West Virginia. But for either the Caddo or Vinton fields in Louisiana, Texas would have become fourth instead of fifth in 1911. It stood fourth in 1913 and 1914, and the next year pushed Illinois out of third place as the result of deep drilling in the Humble pool. Kansas captured third position in 1917 and 1918 despite steady gains in Texas.

‡ The Texas & Pacific Coal (and Oil) Co., through the foresight of its engineer, W. K. Gordon, had leased 375,000 acres of what proved to be the cream of the Ranger field proper before bringing in the McCleskey well one mile southwest of Ranger in August, 1917.



THE POWELL POOL ALONG THE MEXIA FAULT IN NAVARRO COUNTY, TEXAS

At one time, in the fall of 1923, this was the world's foremost producing pool. On one day the 24-hour rate exceeded 350,000 barrels. Its peak record was equalled by the Santa Fe Springs pool in southern California (August, 1923), and surpassed by the Toteco-Cerro Azul in Mexico (December, 1921), and the Smackover in southern Arkansas (May, 1925). (See chart on page 145.)

found on January 7, 1923.† Like the others along the Mexia fault, it is long but narrow, and covers but 2,500 acres, the same as the average of the three great fields of the Los Angeles basin (pages 34-35 and 70-74). Daily yield culminated on November 13, 1923, when nearly 355,000 barrels of 36 gravity oil flowed to the surface, making records for Texas and the United States (up to 1925) but not for the world (see Mexico).* Texas attained an average daily production of 580,000 barrels for the month of November, 1923, the highest in her history. Up to 1925 Mexia, including Currie, had produced almost 73,000,000 barrels in four years and Powell, in two years, 64,000,000. The irrepressible partners, entrepreneur and engineer (Messrs. Humphreys and Fohs), next proceeded to startle the world with the Wortham field, spotted in late November, 1924, and spouting to 167,000 barrels on January 15, 1925, at the rate of 6,000 barrels per well. Wortham holds the world record for rapid development.‡ The only Mid Continent fields ahead of it in daily production during May, 1925, were Smackover, Tonkawa and Burbank. The important pools in the Woodbine sand and in the Edwards lime along the fault zone are compared:

Pools of the Mexia, general Texas area, counties	Area of pool, acres	Length, miles (a)	Year found	Daily yield April, 1925	Total to 1925 (b)
Mexia, East Central, Limestone.....	3,300	7	1920-21	20,000	67.5
Currie, East Central, Navarro.....	600	2	1921	2,400	5.0
Powell, East Central, Navarro.....	2,500	7½	1923	54,000	64.0
Richland, East Central, Navarro.....	300	1¼	1924	7,000	3.4
Wortham, East Central, Freestone.....	900	4	1924	73,000	.8
Luling, Southwest, Caldwell and Gaudalupe..	3,000	7½	1922	30,000	11.7
Totals	10,600	30		186,400	150.9

(a) Along the fault. (b) In million barrels.

‡ The actual discovery was made by the Corsicana Deep Well Drilling Co., whose four-year old test on the Burke farm struck the Woodbine sand at 2,950 feet. It was offset by Humphrey's No. 1 Green-Springfield, considered the best to early April, 1923. Powell production, Jan.-May, was only 30,000 barrels; in June, 445,000; July, 2,185,000 barrels.

* When visited by the author, on April 3, 1924, Powell was producing an average of 200 barrels daily from each of 650 wells, all a little less than 3,000 feet deep.

† It took years to develop to their height some of the biggest fields in the history of oildom. It required from 1875 to 1882 to bring Bradford to its peak; drilling and producing kept on around Cushing three years before its culmination in April, 1915, but Wortham went over the top in just 51 days after Thanksgiving of 1924. See reference to Humphreys-Boyd Oil Co. in chapter "Human Factors and Beneficiaries." Within three months after the first well came in, Wortham became world renowned as evidenced by an article, "The Latest Oil Wonder," which appeared in the *Manchester Guardian Commercial* and was reprinted in *The Baltic-Scandinavian Trade Review* of February 11, 1925

Producing Districts During 1924 and 1925. Texas has now seven producing districts: Electra, Ranger, Mexia, Gulf Coast, Mirando, Amarillo and Marathon. The first three are named after the earliest important pool found in each; but for statistical purposes they are differently designated in the trade journals, namely North Texas, North Central, and East Central. Southwest Texas takes in (illogically) such widely separated fields as Luling (about 45-50 miles northeast of San Antonio), Somerset (16-20 miles southwest therefrom), and Mirando proper (about 30 miles east and southeast of Laredo). Quite properly, the Amarillo district may be considered as Northwest Texas and similarly Marathan as West Central or West Texas; but their output is still so small they are considered "under-studies" to North Central Texas. The Southwest or Mirando district, of steadily growing importance, is grouped with the Gulf Coast considered as a major field (see pages 31 and 33). Considered as districts, however, Gulf Coast and the Southwest are now statistically segregated.

District and principal field or pool			Output in 1924*	Total to 1925*	District and main field or pool			Output in 1924*	Total to 1925*
1	Powell	33.3	64.0		6	Hull (Liberty Co.)	7.4	37.0	
20	Wortham	0.9	0.9						
4	Mexia-Currie	11.6	72.5		9	West Columbia	4.8	54.2	
13	Richland	3.4	3.4		10	Goose Creek (Harris)...	4.3	52.1	
	Mexia or East Central†	46.0	152.0		11	Orange County	4.2	15.9	
7	Electra	7.3	.....		14	Humble (Harris)	2.2	94.9	
17	Iowa Park-K-M-A	1.4	.....		16	Sour Lake (Hardin)....	1.6	65.4	
8	Burkburnett	6.9	108.9		22	Saratoga (Liberty) .....	.6	24.3	
2	Archer County	11.3	12.6		23	Damon Mound .....	.5	5.9	
	Electra or North Texas.	29.0	228.0		21	Barbers Hill .....	.7	1.60	
3	Luling	10.7	11.7						
	Mirando or Southwest...	.....	.....				
5	Stephens County	6.2	94.0			Spindle Top .....	.35	48.35	
18	Shackleford County	1.2	.....			Batson .....	.31	32.0	
12	Ranger-Eastland	3.5	54.0			Blue Ridge .....	.31	2.3	
	Ranger or North Central†	12.5	184.0			Gulf Coast district	27.6	442.4	

The Gulf Coast Has a Great Record. Up to January 1, 1926, the Gulf plains belt had produced practically 512,000,000 barrels of oil, beginning in January, 1901. About 12 percent of the total was derived from Louisiana. The Humble pool is both the largest and the most productive to date. West Columbia contributed the most per acre. The following summary is from *The Oil & Gas Journal*, February 4, 1926.

* Million barrels. † Includes miscellaneous under total for each district; the preceding numbers refer to the recent rank of each district, exclusive of South Liberty, developed in 1925. The above data are from a paper by F. Julius Fohs read before the February, 1924, meeting of the Am. Inst. of Min. and Met. Engrs. He prophesied the finding of the Wortham pool and the expansion of Luling production.

‡ Includes Big Lake in Reagan County which produced 1,060,000 barrels in 1924. It belongs to the Marathon district figures for which are still combined with the totals for the Ranger or North District.

(Footnote on the Luling pool; see table on page 165)

It gets its oil from the Edwards lime, 40 feet of which is productive at about 2,100 feet. The field has a beautiful setting in a farming region. It is almost monopolized by the United North and South Oil Co., organized by a nonprofessional rubber magnate, Edgar B. Davis, of Brockton, Mass. His persistent wildcatting at a cost of \$1,200,000 for three years was finally crowned with success on August 9, 1922. His was one of the best exhibitions of financial nerve in the history of oil, according to James McIntyre in *The Oil and Gas Journal*, May 15, 1924.

GROSS PRODUCTION FROM THE GULF COAST BELT, 1901-1925, WITH AREA AND DATE

Name of pool	Year opened	Area, acres	Million barrels	Name of pool	Year opened	Area, acres	Million barrels
Spindletop	1901	240	48.8	West Columbia.....	1917	785	57.5
Sour Lake.....	1902	1,200	66.8	Hull	1917	1,500	44.2
Jennings (La.).....	1902	750	35.9	Barber Hill.....	1918	25	0.7
Batson	1903	650	32.5	Blue Ridge.....	1919	410	2.0
Saratoga	1904	1,125	30.0	Pierce Junction.....	1921	205	3.0
Humble	1905	3,200	75.8	Big Creek.....	1922	425	0.6
Welsh-Anse, La. B.....	1905	...	0.8	High Island.....	1922	180	0.2
Dayton	1905	125	0.7	Stratton Ridge.....	1922	50	.03
Vinton (La.).....	1910	1,500	26.6	Lockport (La.).....	1924	...	.7
Goose Creek.....	1912	2,050	53.0	South Liberty.....	1925	750	4.7
Orange	1913	1,325	21.7	Boling	1925	...	.04
Damon Mound.....	1917	255	6.0	Piedras Pintas.....	1925	...	.01



—The Oil Weekly

A GULF COAST POOL, GOOSE CREEK.

25 MILES EAST OF HOUSTON

Opened in 1908 with a 1,600-foot well of 800 bbls. Big development began in 1916, at 2,030 feet before 30,000-bbl. gushers came in at 3,000 feet. General area, 2,050 acres; productive, 880 acres with acre-yield about 63,000 bbls. to end of 1926. In 1918 led Humble, producing 6,348,000 bbls. With over 7,000 bbls. daily in November, 1926, Goose Creek ranked fourth among Gulf Coast pools, Spindle Top having over 90,000 bbls.; Hull, 20,000; West Columbia, 8,500; Orange, 6,700 and Sour Lake 6,300, out of a total of more than 175,000 bbls. daily.

The year 1926 marked an era of deeper drilling on the coast. Through deep wells, some below 5,000 feet, Spindle Top was rejuvenated so that its 1926 output is estimated about equal to that of its banner year 1902, when 17,420,000 bbls. were produced. At Goose Creek a Gulf Production Co.'s hole had reached 5,600 feet in November. The deepest producer east of California was reported in Cameron Parish, Louisiana, about 5,800 feet deep. The Gulf Coast field reached a new high peak in 1926.

A TRIUMVIRATE OF PETROLEUM STATES

Three-fourths of Petroleum Produced by Three States. Single states in a few instances contribute at least half or nearly half in the output of certain commodities. Thus California is the source of 85 percent of the placer gold! Florida, of 65 percent of the phosphate rock; Minnesota, of 59 percent of the iron ore; Vermont of 48 percent of the marble; Arizona of 46 percent of the copper; Pennsylvania, of 46 percent of the slate and practically all of the anthracite. Very rarely is the degree of geographic concentration so great as to permit no more than three states to control at least 75 percent of one raw product as is the case with crude oil. California and Texas practically monopolize the production of quicksilver, Texas and Louisiana that of sulphur, California and Nevada that of borates, and California and Washington that of magnesite. In 1922 and 1923 the three states of Minnesota, Michigan and Alabama supplied respectively 97 and 92.5 percent of all the iron ore mined in the United States. Naturally, since the bulk of the tremendous increase in petroleum production of the United States during the past few years has come out of California, Oklahoma and Texas, the percentage control by these states has also increased. They contributed 69.4 percent in 1920, 70.5 percent in 1921, 73 percent in 1922, 76 percent in 1923, and 75 percent in 1924 when the total output fell off.

Each of the Three States Supreme in Some Feature. California delivers oil at tidewater at lowest cost because it produces most oil from fewest wells and over half of it less than 30 miles from a sea port. Oklahoma leads in output of light oil and hence in total value; but having more than twice as many wells as California and Texas together is handicapped by higher costs of development rather than of pumping. Texas obtains petroleum from the greatest variety of structures—anticlines, fault zones, salt domes, etc.—and from strata differing most widely in age and depth; hence offers crude oils of great range in quality (pages 28, 33 and 36). This state, as observed in the table of comparison below, has an extent of possible but unexplored oil territory greater than the total area of Oklahoma. F. Julius Fohs declared that, as California has very restricted areas in which undeveloped pools or deeper sands are likely to be opened; Texas, although now third in production, because of its large undeveloped areas, within five years should rival Oklahoma for first place.

COMPARISON OF THE THREE GREAT AMERICAN OIL STATES, 1924-1925

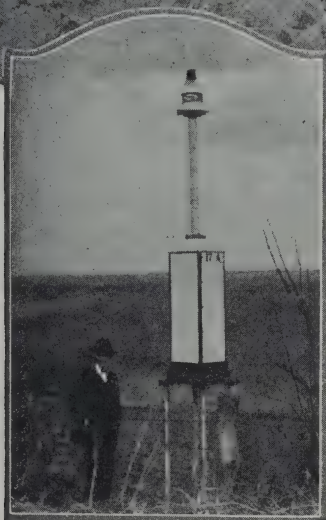
Points of comparison	California	Oklahoma	Texas
Area in square miles (land and water).....	158,297	70,057	265,896
Area possible oil provinces.....	1,500	30,000	80,000
Area proven and probable.....	182	1,800	2,500
Area producing during 1925.....	100	1,250	500
Usual range in gravity of oil.....degrees Baumé..	10-40	28-43	18-41
Number producing salt domes.....	None	None	24
Number producing areas altogether.....	35	175	110
Daily yield, leading pool, June 30, 1925.....barrels..	108,000	57,000	47,000
Daily yield, entire state, June 30, 1925.....do....	650,000	450,000	425,000
Leading county, late 1926.....	Los A.	Seminole	Hutchinson
Second county, late 1926.....	Kern	Osage	Jefferson
Daily yield, leading pool or area, late 1926.....do....	95,000	111,000	148,000
Daily yield, entire state, late 1926.....do....	660,000	540,000	630,000
Number of counties with oil and gas.....	7	45	70
Number producing wells, 1925.....	11,500	62,500	17,600
Daily yield per well, April, 1925.....barrels..	52	7	24.4
Population, January 1, 1925.....millions.....	4	2.2	5.1
Per capita production, 1924.....barrels.....	58	78	26
Per capita production to January 1, 1925.....do....	525	760	195
Total output to January 1, 1927.....million barrels..	2,550	1,975	1,300
Year of commercial discovery.....	1875	1891	1889
Year output passed 1,000,000.....	1895	1904	1901
Output in 1907.....million barrels..	39.8	43.5	12.6
Ratio of 1924 output to above.....	6	4	10.8
New wells in five years, 1920-24.....	4,331	31,516	26,162
Percent dry holes of above.....	15	25	31
Refining capacity, crude, daily.....	744,000	349,000	567,000
Refining capacity, percent, United States.....	25	12	19
Motor vehicle registration, January 1, 1925.....	1,319,000	374,000	802,000
Number of persons per motor vehicle.....	3	6	6.3
Number of miles surfaced roads.....	14,275	2,461	14,883
Crude yield per motor vehicle, 1924.....barrels..	176	467	168.5
Reserves underground*.....million barrels..	2,800	2,100	3,500
Pipe lines (trunk and gathering) Jan. 1, 1924.....miles..	4,539	17,384	12,044

* Materially modified from the estimates offered on page 39, in the light of later developments. Since the above was written there has appeared, August, 1925, "American Petroleum Supply and Demand," published by McGraw-Hill Book Co., New York, for the American Petroleum Institute, 250 Park Avenue. Price, \$3.

THE DISTRIBUTION OF REFINERIES*

Principles Concerning the Location of Petroleum Refineries. These are:

(1) Nearness to domestic markets; (2) proximity to producing fields, and (3) accessibility to tankers for receiving crude oil and for shipping refined products by water. The first and third are sound economic reasons, for they permit respectively shorter railway hauls on refined products and low freight charges on the shipments overseas or coastwise. Realizing this, the leading refiners have spotted 16 out of the 22 largest plants either along



—Standard Oil Bulletin

A MODERN REFINERY ON SAN FRANCISCO BAY

This is one of two 100,000-bbl. plants of the Standard Oil Co. of California—this one at Richmond, the other one at El Segundo, near Los Angeles.

By absorbing Pacific Oil Co. in 1926 the California Standard further strengthened its position as the principal refiner and marketer on the Pacific Coast and as the world's second in refining capacity.

As an aid in aviation, the Richmond refinery may be identified from the air. At the left is shown one of the land beacons on the air route between New York and San Francisco.

tidewater or near the mouths of navigable streams.* The territory around New York and Tampico illustrate respectively (1) and (2) (see page ..). The Los Angeles district illustrates all three principles.

Influence of Life on Location in Field. Unless an inland pool or group of pools constituting an oil field gives promise of long life it is not a good business practice to place a refinery where the raw material is produced except where also centrally situated with reference to regional or local markets. Tulsa, the capital of oildom, contains in her suburb west of the Arkansas River, the Cosden refinery which is the largest in the Mid-Continent field. As will be seen in the table herewith, this refinery is hardly two-fifths the size of the average for the six foremost refineries which are all located along water fronts. In general, only refineries of limited

* "The location is a purely economic problem, but with the unfortunate corollary that with the slowly changing cycles of industrial development the program which, in a particular territory is most profitable at a given time, may, however, become decidedly unprofitable a few years later. It would appear both logical and economic to build a refinery in the heart of its market." Charles E. Bowles, in the *Oil and Gas Journal*.

capacities and of the skimming type are located inland near the sources of crude supply. Perhaps the proper solution will be to build portable plants; then there will not be so many refineries shut down in the oil fields.

LEADING REFINERIES AND THEIR POTENTIAL CAPACITIES IN THOUSANDS OF BARRELS, JANUARY 1, 1926

Operator and location		Capacity	Operator and location		Capacity
Gulf Ref. Co., Port Arthur, Tex.....	102		Shell Co. (Calif.), Martinez, Calif.....	40	
Standard (Calif.), Richmond, Calif.....	100		Midwest Refining, Casper, Wyo.....	50	
Standard (Calif.), El Segundo, Calif.....	100		The Texas Co., Pt. Arthur, Tex.....	50	
Standard (N. J.), Bayonne, N. J.....	100		Magnolia P. Co., Beaumont, Tex.....	45	
Standard (La.), Baton Rouge, La.....	60		Tidewater O. Co., Bayonne, N. J.....	36	
Standard (N. J.), Linden, N. J.....	75		Union Oil Co., Los Angeles, Calif.....	40	
Standard (Ind.), Whiting, Ind.....	50		Standard (N. J.), Baltimore, Md.....	32	
Pan American P. Co., Watson, Calif.....	70		New Eng. O. Ref., Fall River, Mass.....	30	
Associated Oil Co., Avon, Calif.....	50		Roxana Pet. Corp., Wood River, Ill.....	30	
General Pet. Corp., Vernon, Calif.....	50		Cosden & Co., West Tulsa, Okla.....	35	
Atlantic Ref. Co., Philadelphia.....	50		(Now Mid Continent Oil and Gas.)		

Only 3 out of these 21 are not complete refineries.

The Three Leading Oil States Have 57 Percent of Refining Capacity. California, Oklahoma and Texas contributed together 75 percent of the crude oil produced in the United States in 1924, but on May 1, 1925, they had but 57 percent of the total refinery capacity. The two states on tide-water can refine 30 percent more crude than they now produce. Oklahoma can skim or otherwise refine 100,000 fewer barrels per day than it was daily producing in April, 1925; and on May 1, 1925, refineries with 30 percent of the total capacity for the state were shut down. It is plainly more profitable to pipe the crude oil to waterways than to pay railway rates on products in containers or even in tank cars. How overbuilt is the refining capacity of several states besides Oklahoma is set forth in the column of the table below headed "Per cent shut down." (See page 84.)

States	No. of refineries	Daily capacity M bbls.	Percent shut down	Principal center
1 California	87	744	5	Los Angeles County
2 Texas	113	567	16	Port Arthur-Beaumont
3 Oklahoma	93	349	30	Tulsa and West Tulsa
4 New Jersey	6	243	2.5	Bayonne-Jersey City, etc.
5 Louisiana	26	166	12	Baton Rouge-Destrehan
6 Pennsylvania	59	144	3.7	Philadelphia
7 Kansas	34	137	16	Arkansas City
8 Wyoming	16	100	6.7	Casper (Natrona County)
9 Illinois	14	90	15.5	Wood River
10 Indiana	6	76	6.5	Whiting
11 Massachusetts	3	52	0	Fall River
Total, 11 states.....	457	2,668	11.7	
Other 19 states.....	97	267	11.7	

Maryland has four refineries with 45,200 barrels daily capacity, 84 percent at Baltimore. Ohio, the 13th state in refining, has 13 plants of 45,000 capacity, half at Toledo. Arkansas lately passed New York in total capacity—36,000 barrels, half at El Dorado and 38 percent shut down. Kentucky, Missouri, Rhode Island and Montana each have a greater capacity than West Virginia. South Carolina, the 21st state, can refine as much as Virginia and Utah together. Georgia can refine more than Iowa and Colorado. Minnesota, New Mexico, Arizona and Tennessee distill trivial quantities. Last or 31st is Mississippi. Thirty percent of our domestic distilling of crude oil is done in the three great refining regions, the Los Angeles district (including northern Orange County), the New York Bay area and the Neches River from Port Arthur to Beaumont.

CHAPTER IX—GEOGRAPHY OF THE MARITIME TRADE

TANKER TRANSPORTATION

Learn up geography—work out your sums,
 Build up your commerce, and pull down your slums;
 Sail on a tanker that marks a full hold;
 Your overseas trade means a harvest of gold.
 Bring in the crude oil and asphalt you've bought,
 But send out refined the raw you import;
 Trade your inventions, your labor and sweat,
 For your overseas traffic will keep you from debt.

—Modified from *Our Merchant Marine*, H. C. Wiltbank, Editor, Feb., 1923.

Preponderance of Tankers in Our Merchant Marine. From the table below it appears that 40.3 percent of the total privately owned deep-sea shipping (counting only vessels of 1,000 gross tons or more) consists of petroleum tankers. In the foreign trade, however, the American tankers are even more important since they therein make up 44.3 percent as of April 1, 1924. This accounts for the fact that the foremost commodity in the foreign trade and total trade of the six leading seaports in 1922 and of seven in 1923 consisted of mineral oil and its products (see pages 20, 21 . .). Accordingly, the sudden cutting off of our immense foreign trade in petroleum would mean a calamity not only to American shipping but also to many sea-ports and refining centers located particularly along the Atlantic coast. Considering tankers alone, 32 percent of them were employed in the foreign trade during the spring of 1924, or if the idle tonnage be excluded from the total, then they made up 35.7 percent of the total. This total covers both Government and privately owned tankers.

SUMMARY OF UNITED STATES STEAM AND MOTOR VESSELS OF 1,000 GROSS TONS AND OVER, APRIL 1, 1924

Tanker service	Privately owned		Government owned		Total both ownership	
	Number	M gross tons	Number	M gross tons	Number	M gross tons
Latin-American (90% Mexican)....	90	516	5	25	95	541
Transatlantic (European W. coast)....	17	108	0	.....	17	108
Transpacific (93% Oriental).....	12	95	1	6.5	13	101
Total in foreign trade.....	119	719	6	31.6	125	750
Coastwise:						
Atlantic	80	450.2	1	6.8	81	457
Pacific	24	120	3	20.1	27	140
Intercoastal	87	682	10	67.4	97	749
Hawaiian	2	9.1	1	6.6	3	15.7
Total in domestic trade.....	193	1,261	15	100.9	208	1,362
Total in foreign trade.....	119	719	6	31.6	125	750
Laid up vessels.....	24	83	29*	149.5	53	233
Total tankers	336	2,063	50	282	386	2,345
Nontanker service:						
Freight	592	2,281	1,191	5,321†	1,783	7,602
Passenger	165	777	33	467	198	1,244
Total Merchant Fleet.....	1,093	5,121	1,274	6,070	2,367	11,191‡

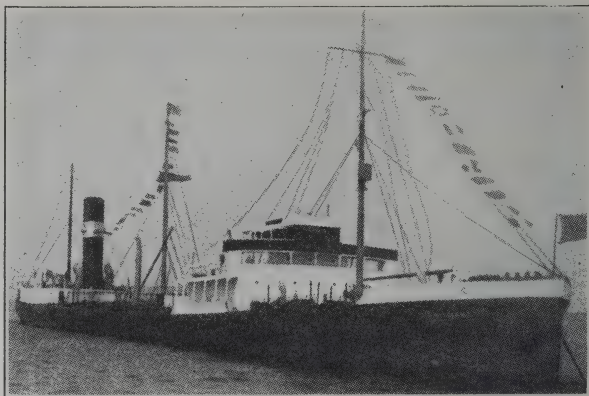
* These 29 include seven concrete tankers.

† The total number of Government freight vessels (non-tankers) include 842 laid up vessels with total gross tonnage of 3,517,341.

‡ Exclusive of two and one-half million gross tons in the Great Lakes commerce and a smaller tonnage in the river trade of the interior.

FIRST TANKER OF COLOMBIAN CRUDE OIL

The "T. J. Williams," Capt. F. Hultgren, in July, 1926, cleared the port of Mamonal in Colombia (near Cartagena) with 80,000 bbls. of oil from Las Infantas field for Bayonne, N. J. See Chapter X and U. S. Commerce Reports, August 23, 1926.



—The Lamp

Extensive as the tonnage tankers engaged in foreign trade appeared to be, it was practically equalled by that engaged in the domestic intercoastal traffic, meaning the traffic through the Panama Canal in 1924. Looking at the closer classification, the tanker service resolves itself into the following leading groups towards the middle of 1924; based upon the active tonnage as 100 percent:

	Percent		Percent
Domestic intercoastal	35.5	Pacific coastwise (domestic).....	6.7
Latin-American	25.7	Transatlantic	5.1
Atlantic coastwise (domestic).....	21.7	Transpacific	4.8

The Movement of Mineral Oil Through the Panama Canal. This movement, especially eastwards, gained momentum during the past five years on a scale unbelievable. It culminated unquestionably in 1923 when 64,000,000 barrels of California petroleum passed through the man-made waterway. This was but little more than the Pacific coastwise movement out of Los Angeles harbor, mainly to refineries near San Francisco. It was the shorter distance between these two ports that explains why less than one-fifth as much as the tanker tonnage occupied in domestic intercoastal traffic could carry almost 60,000,000 barrels of oil last year to the former metropolis of the Pacific Coast. It will be noted that not all of the oil passing through the canal was domestic intercoastal. Much of the movement was to Mexico for the purpose of keeping its refineries busy in view of the changing complexity of the Mexican production (see Chapter X. The Panama petroleum traffic eastbound was only 16,000,000 barrels or 22 percent less than our Atlantic and Gulf Coast imports of Mexican, Peruvian and Venezuelan crude oil in 1923.*

American Oil in American Bottoms; Other Goods in Foreign Bottoms. It is a source of pride to the American petroleum industry that it is practically independent of foreign bottoms in the marine transport of mineral oil. On the other hand it is a source of disgrace that for 60 years, or since the close of the Civil War, the United States foreign trade as a whole

* Of all forms of petroleum the Pacific to Atlantic traffic was 9,720,000 tons, or 50.8 per cent of all commodities in the fiscal year ended June 30, 1924; it was 5,990,000 tons, or 36.3 per cent in the fiscal year 1925, and 5,785,000 tons, or 32.7 per cent in the fiscal year 1926. Only 1,080,000 tons, or 13.8 per cent, of the west-bound traffic was petroleum in the fiscal year 1924; 950,000 tons, or 12.8 per cent, in 1925, and 720,000 tons, or 9 per cent in 1926.

has been at the mercy of foreign shipping in the carrying of commodities in and out of American ports. This condition was worst during the 15 or 20 years preceding our entry into the World War, for in that period we rarely transported as much as 10 percent of our combined exports and imports. An era of ship-yard expansion ensued, first to furnish warring nations with new vessels, and next to build a bridge of boats* to carry some of our own supplies and troops across the sea.

A recent high point in self-sufficiency was reached in the fiscal year 1920 when ships flying the American flag freighted 42.7 percent of our exports and imports. In that year our foreign trade attained its peak value of almost \$11,875,000,000. From that high point the decline has been rapid. During the fiscal year ended June 30, 1922, we hauled hardly 35 percent of the goods involved in our foreign trade despite the drop in the total value to \$5,523,000,000. In other words, more than 65 percent of these goods were carried in bottoms owned abroad. Altogether between the end of the Civil War and the beginning of the World War 85 percent of the \$83,585,000,000 value of cargoes coming into and going out of the United States was transported in foreign ships. Said Governor Parker of Louisiana quite lately: "It is a pity to see the greatest producing nation depending upon foreign bottoms for the transportation of its agricultural and manufactured products."

Function of the Tanker Fleet in Time of War—Treasure vs. Tragedy. Our country was indeed fortunate to find itself in possession of a formidable tanker fleet at the time of entry into the war. Its importance can hardly be overestimated (see cut, page 39). Would that the rest of our merchant marine were as ready for emergencies! Mr. Hughes, while Secretary of State, said, "An adequate merchant marine effectively maintained would not only promote the commerce, but would support our influence abroad, and constitute a bulwark for the safety of the nation." Secretary Mellon made the remark "that all patriotic Americans wish to see our country restored to her rightful place on the seas." The American tanker fleet almost alone and for a long time has been the means of maintaining our prestige abroad. Were it not for one such fleet—the one operated by the Standard Oil Company of New Jersey—no American ship line would rank among the first forty in the world; and the American Tanker fleet has never been subsidized one cent! Nevertheless it was the bulk-oil boats of both the Pan-American† and the Standard which successfully and with considerable sacrifice met the emergency call for liquid fuel during the late war.‡

* "Across the sea A bridge must be
Of boats to freight Our troops though late
Procrastinate Through party hate
Bids fair to wreck Our Nation's deck."

—From "We Must Unite, The Foe to Fight," by O. H. Reinhold. Published in *The Madison Democrat*, March 28, 1918.

† "Martyr we made you, the next E. L. D.
Whose vigor and vision helped bring victory
Through oil well and tanker and refinery
Owned by Mexican Pete, well known on the Street."

‡ The Sun Shipbuilding Company's yard at Chester, Pa., has built more tankers than any other plant in the United States. Its President is John G. Pew (page 89), and its Vice-President Robert Haig, a cousin and namesake of the hero of Vimy Ridge.

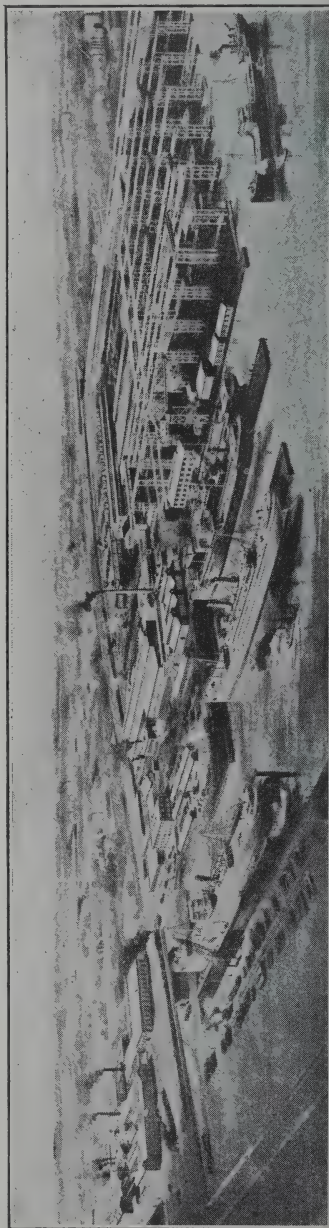
TONNAGE OF FOREIGN TRADE IN PETROLEUM

Comparison With Other Commodities. The Division of Statistics, Bureau of Research, U. S. Shipping Board, has supplied the following figures for the fiscal year ended June 30, 1924, showing the number of cargo tons (of 2,240 pounds) of the leading commodities imported and exported, arranged by the author in the order of quantity, thousands being omitted:

Imports	
1 Crude petroleum.....	14,382
2 Wheat	3,902
3 Sugar	3,355
4 Iron ore	2,484
5 Logs and lumber.....	1,438
6 Bananas	1,090
7 Nitrates (Chili?)	941
8 Molasses	891
9 Coffee	672
10 Vegetables and products.....	655

Exports	
1 Petroleum and products.....	12,937
2 Coal and coke.....	9,937
3 Wheat	5,369
4 Lumber	4,584
5 Wheat flour	1,966
6 Iron and steel, incl. mfrs.....	1,354
7 Raw cotton	1,301
8 Iron ore	1,014
9 Phosphates	836
10 Meat, fish and dairy products....	732

Tremendous Increase Over Pre-War Imports of Crude. How great has been the growth in our domestic and export demand for petroleum is evidenced by the tenfold increase in our imports during the decade ended with 1922. Our annual imports of crude oil averaged 2,000,000 long tons in the 5-year period, 1909-1913; a little over 21,000,000 tons in the two years, 1921-1922; dropping to hardly 13,000,000 in 1923-1924. Receipts of refined mineral oil, as elsewhere explained, have also risen rapidly, from the pre-war average of less than 100,000 long tons to nearly 2,000,000 tons average in 1921 and 1922, and to 2.4 million tons in 1923 and 1924. Other leading imports in respect to quantity stood almost stationary during these periods, cane sugar amounting to 3.5 million tons in 1909-1913 (5-year average) and practically the same (3.7 million tons) in 1923-1924, with a peak of almost 5,000,000 tons in 1922. Pulpwood increased from 1.8 million tons to 2.4 millions; iron ore from 2.4 to 2.6 (millions), and wood pulp from half a million to 1.4 million tons. It thus appears that, despite a temporary drop in crude oil imports, the average annual tonnage thereof and of refined oil during the past two years made together almost half again as great a tonnage as the total of the other four out of six leading imports.



SHIPYARD OF SUN SHIPBUILDING AND DRY DOCK CO., CHESTER, BELOW PHILADELPHIA

Where the Imports Came In. In the table below are shown the receipts of the four leading imports according to weight, distributed by coastal districts for the fiscal year ended June 30, 1924. As indicating one cause of our chronic dental troubles, it may be stated that all our crude oil imports, constituting one-third of all our imports according to quantity, make but eight (8) percent of the world's entire production of oil; whereas, our imports of almost three and one-half million tons of sugar make fourteen (14) percent of the world's overproduction of such sweet stuff.

District	Iron ore	Sugar	Wheat	Crude oil	Total	Percent crude oil
Gulf	18	588	.....	7,103	10,205	70
North Atlantic	2,438	2,544	1.6	6,592	22,600	29
South Atlantic	14	146	.....	675	1,666	40
Pacific	3	76	0.6	12	2,559	0.5
Great Lakes	10	.....	3,900	0	5,731	0
	2,483	3,354	3,902	14,382	42,750	33.6

An inevitable conclusion is that mineral oils, notably fuel oil, are making absolute and relative headway at the expense of coal and coke.

Where the Exports Went Out in 1924. The Gulf district has generally led in the percentage which petroleum and its products have made of the total exports according to tonnage; but in both absolute quantity and value the North Atlantic district, the port of New York in particular, had held first place before 1923. The temporary leadership in percentage passed to the Pacific district due to the tremendous traffic out of San Pedro which in turn was caused by the extraordinary output of the Los Angeles basin during the past two or three years.

District	Petroleum, products	Coal, coke	Wheat, flour	Lumber	All exports	Percent petroleum
Gulf	4,665	92.6	683	1,782	10,524	44
Pacific	4,364	3.1	1,446	2,461	9,487	46
North Atlantic	3,829	4,078.3	4,381	223	20,276	19
Great Lakes	33	5,563	823	12	7,980	0.4
South Atlantic	45	201	.....	105	856	5.2
Total	12,937	9,937	7,334	4,583	49,122	26.3

Several significant facts are brought out in the table above. Aside from the striking features relating to petroleum it appears that each district, except the South Atlantic, held a pronounced leadership in one of the four most important exports measured in tonnage. Thus 54 percent of the lumber shipments abroad originated on the North Pacific coast, while 60 percent of the wheat and wheat flour left from ports of the North Atlantic. Of the coal and coke, 56 percent was carried from Lake Erie ports to various parts of Canada. These statistics relate to the fiscal year ended June 30, 1924, and sustain statements made elsewhere that *fully one-fourth of all the exports from the United States is now made up of mineral oil.*

FOREIGN COMMERCE OF THE UNITED STATES, 1922-1924

1. THE IMPORT TRADE IN PETROLEUM

World's Biggest Buyer of Crude. Contrary to the prevailing impression, Uncle Sam is the world's leading importer of mineral oil. But the import trade did not become important until a decade ago, that is, after the advent of Mexico into high rank as a source of fuel oil for the world's fighting fleets and merchant marines.* In fact, not before the fall of 1923,

* During the 5-year period, 1910-14, no refined oil was imported, and the crude imports made but three-tenths of 1 percent of the value of all imports. In 1922 2.3 percent, and 1923, 1.4 percent of imports were crude oil.

when a cargo of crude oil came from the Maracaibo basin of Venezuela,† was there any record of receipts of foreign petroleum other than Mexican (with minor amounts of Peruvian and Trinidad crude) at ports of the United States. Practically all of the imports listed below may therefore be credited to our nearest Latin-American neighbor; and all of them entered the United States *free of duty*.

IMPORTS OF MINERAL OIL LAST THREE CALENDAR YEARS

Articles	Unit	Thousands of barrels			Value, thousands		
		1922	1923	1924	1922	1923	1924
Crude petroleum	barrels..	127,000	82,000	77,800	\$70,383	\$53,882	\$ 73,842
Topped prod. (fuel oil, etc.)..	do....	2,950	12,200	12,900	1,657	7,526	12,690
Unfinished products	do....	4,220	760	320	10,705	1,690	950
Finished light products.....	do....	1,480	4,550	3,430	5,440	14,803	13,000
Illum. and lub. oils.....	do....	0	36	90	0	252	325
Total liquid products.....	do....	135,650	99,546	94,540	\$88,185	\$78,153	\$100,717

Two Causes of Decrease. In 1923, by a mere coincident, 82 percent of the imports consisted of crude oil while 82 percent of the exports were refined products. The decrease in crude imports, absolutely 45,000,000 barrels in one year, was due first to the great drop of 32,000,000 barrels in the output of Mexican wells and next to the stupendous rise of over 175,000,000 barrels in the domestic yield. In 1924 the high rate of decrease in quantity was arrested, as indicated and the total value of the imports passed the 100,000,000 mark for the first time. In 1925 imports fell off 17 percent to 78.3 million barrels from 94.5 million in 1924. Small increases occurred in the receipts of refined products. Of the liquid imports, 81.6 percent consisted of crude oil—62 million barrels.

Reasons For Gain in Refined Imports. The 207 percent gain in quantity of finished light products imported in 1923 was not caused by any improvement in the quality of Mexican crude oils. The latter averaged much heavier than in a dozen years due to a continued decrease in the production of southern or light oil and an increase in that of heavy or Panuco oil. This practical trebling in both bulk and value of such refined imports may be explained by the diversion of some California light oil to the otherwise idle Tampico refineries in order to relieve the congestion at plants near Los Angeles.

Position of Petroleum in the Import Trade. In the point of value for the calendar year 1923, seventeen, and for 1922, only seven other commodities surpassed crude oil among the imports of the United States.

THE EIGHTEEN LEADING IMPORTS INTO THE UNITED STATES

(Values in Millions)

Commodity	1923	1922	Commodity	1923	1922
Silk, raw	\$392	\$366	Burlaps, jute	\$67	\$49
Sugar, cane	380	252	Vegetable oils	65	59
Coffee	190	161	Fertilizers	64	45
Rubber, crude	185	102	Lumber (boards, etc.)	62	46
Wool, mohair	120	87	Tin (bars and block)	61	41
Hides and skins	119	107	Diamonds	60	52
Paper, newsprint	98	72	Tobacco, raw	57	66
Furs, undressed	80	62	Copper, crude	56	38
Wood pulp	75	63	Mineral oil, crude	54	70

* Trade information, Bulletin No. 225, May 5, 1924, U. S. Dept. of Commerce.

† According to the *Oil and Gas Journal*, December 6, 1923, this was brought by the tanker "Sabin Run" for the Sun Oil Company's plant at Sandy Hook. But *Commerce Reports* of November 19, 1923, states that on October 2 the third shipment of Venezuelan oil—68,000 barrels or 9,715 tons—was made to Perth Amboy, N. J., by the Curacao Petroleum Company. See view of first cargo of crude from Colombia, page 172.

Refined Oil Rose in Rank. Although partly accidental, yet suggestive of what the future holds forth, refined oil imports came up to 29th place in 1923 from 32nd in 1922, while imports of crude fell off 10 places as stated above. The products of lawful distillation stood as low as 39th in 1921. In addition to the 18 commodities listed in the table, 10 other articles of import were worth more than the refined forms of petroleum: Raw cotton, flax-seed, cotton cloths, fruits, crude cocoa, tea, fish, vegetables, woven fabrics of flax and hemp, and nuts of all kinds. These 10 varied in value from nearly \$50,000,000 for each of the first two down to a trifle over \$25,000,000 for the nuts. Imports of refined oil amounted to \$24,272,000 in 1923 compared with \$17,802,000 in 1922, a gain of 36 percent. This rate of increase was exceeded by that of two other mineral commodities, namely tin and unrefined copper.

2. THE EXPORT TRADE

Oil One of the Greatest Forces in Our Foreign Trade. As implied at the beginning of this chapter, and as claimed by good authorities* the petroleum industry has probably proven the greatest single force in expanding the foreign trade of the United States. With the notable exception of our sister republic to the south, in no other nation's dealings with foreign lands does petroleum play a more important part.† As shown in a following table, in the value of exports mineral oil ranks safely second to only one other commodity, namely raw cotton. It contributes, therefore, a big share towards our favorable balance of trade. Moreover, in providing light, heat, and lubrication to the remotest corners of the earth, the American petroleum industry has increased the prestige of this country throughout the wide world; it has exercised a great civilizing influence and has increased the capacity of foreign countries to purchase other American products.

Importance of Maintaining Foreign Markets. Exceedingly important is the export trade in American petroleum products. Its preservation and extension is very vital to the continued growth and prosperity of the American petroleum industry. Not only are the exporters interested therein, but the American public, the world's principal consumer, probably understand by this time that reasonable prices for gasoline and other products are made possible by the higher prices and profits obtainable on the exports; and also, that, without a foreign outlet for our surplus kerosene in particular, any losses sustained through a domestic overload of this illuminant would have to be met through increased charges for the more popular products. (See pages 66, 84 and 85.‡)

* "The Oil Industry's Answer" (to its critics), reprinted from *The Oil and Gas Journal*, Tulsa, Okla., 1924.

† Russia's great oil industry was temporarily removed, as a result of the World War, from competition with the American industry which it led in production at the beginning of this century. According to Julius Klein, in *U. S. Commerce Reports* for September 8, 1924, "the Russian industry has been struggling with ignorance, inappreciation, and political strife at home, and the competition of highly organized distribution in the world's markets. During 1917-1918 much damage was done to oil properties, and the nationalized industry handicapped for lack of labor, equipment, and technical personnel. But because of the richness of the Russian deposits, the industry has revived. In the petroleum markets of Europe it is (again) coming into competition with American products."

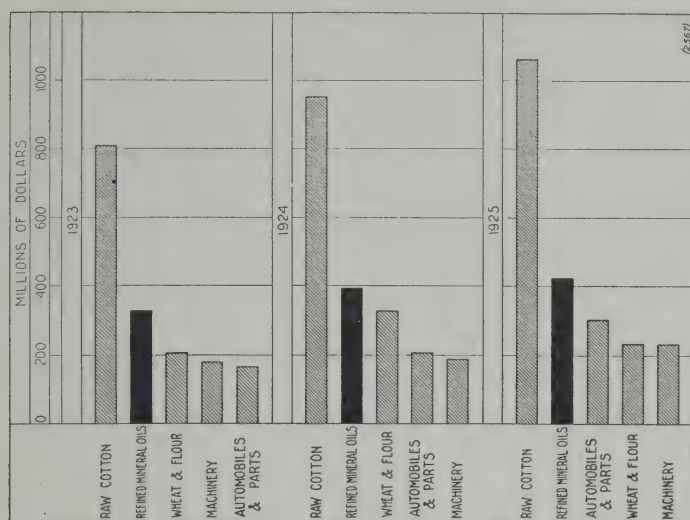
‡ Read "Importance of Foreign Markets to the Petroleum Industry," by Henry C. Morris in *U. S. Commerce Reports*, June 18, 1923, page 753; "World Looks to America for Petroleum," by W. M. Dunham in *The Oil and Gas Journal*, November 8, 1923; "Export

Patient Efforts Have Built Up the Business. To get an entry into foreign markets for any American manufactured product is a difficult proposition, and the result is apt to become unsatisfactory unless the business is voluminous enough to warrant considerable expenditure of time and money. While the various Standard companies, notably those of New Jersey, New York and Vacuum, collectively still control the export trade (page 103), the leading independents and semi-independents, such as Gulf Refining, Pan-American, Sinclair, Sun Oil Co., The Texas Co., and Union Oil Company of Calif., in the course of 20 years have developed a large lucrative share therein, and this share has expanded surprisingly since the war. Their participation therein and the general exportation of refined mineral oils, should be encouraged since the latter serves as a sort of latch key in opening the door for American capital in the development of foreign fields upon which, in turn, we must draw increasingly in coming years to supplement the diminishing returns from our own deposits.

Federal Interference to Restrict Exports. In behalf of the national defense a curtailment of petroleum exports is proposed through some legal measure other than an export duty which is unconstitutional. Any such artificial restraint is not regarded by the writer as advisable since it would prove at present disadvantageous in various ways. One reason is that it would permit, even if it would not stimulate, in the United States an outrageously higher per capita consumption. In 1923, when our population approximated 110,000,000, each person on the average used about 240 gallons or 5.7 barrels of mineral oil. This quantity is practically three times the per capita consumption in Canada, eight times that in the United Kingdom or in Mexico, almost 20 times that in France or Russia, 51 times that in Italy and 86 times that in Germany during the year 1923. (See tables on pages 15 and 191.) Furthermore, such restraint would prove a rude reward for promoting the expansion of foreign trade in other American commodities, notably automobiles, which has followed the flag of our petroleum fleet. Probably no other American product has penetrated into so many out-of-the-way places as refined petroleum, from the South Pole to the Northwest Passage. (See pages 17 and 95.) The strongest argument against unnatural restriction has been stated in the preceding paragraph.

Position of Petroleum in the Export Trade. In view of what appears above it is not surprising to note that refined mineral oil ranks well ahead of all other exports with the single exception of unmanufactured cotton. Moreover, the article which stands third or next to refined oil is one that owes its development to the existence of a suitable propelling energy derived from crude oil (page 107). In former years, especially before the World War, copper and iron and steel stood highest among the exports of metals and minerals or their products; but now the new leaders are refined oil, automobiles, and coal. Among the exports of 1923, petroleum products were worth three times the value of refined copper and four times the value of cotton cloth. Even crude mineral oil, which ranked but 23rd in 1923, slightly exceeded cigarettes in value of exports, while the refined oil was worth more than twice as much as leaf tobacco.

Trade and the Investor," W. F. Keyes in the *Magazine of Wall Street*, September 30, 1922; "Principles of Foreign Trade," by C. E. Griffin (The MacMillan Co.) notes that the United States stood only 22nd in per capita foreign trade among the nations of the world in 1913.



POSITION OF REFINED MINERAL OILS SECOND
AMONG MAJOR EXPORTS OF THE UNITED
STATES IN LATE YEARS

The annual value of both refined and crude forms of petroleum now (1926-1927) approximates \$500,000,000.

THE 24 LEADING EXPORTS IN 1923 (VALUES IN MILLIONS OF DOLLARS)

Commodity	1923	1922	Commodity	1923	1922
Cotton, raw	\$807	\$672	Bacon	\$60	\$52
Mineral oil, refined	327	313	Hams	59	57
Autos and parts	166	98	Iron and steel	59	46
Coal	154	91	Agricultural machinery	50	26
Tobacco leaf	152	146	Leather	43	45
Lard	133	94	Corn (maize)	37	115
Wheat (grain)	116	206	Sugar	29	70
Copper, refined	110	89	Rye (grain)	28	46
Wheat flour	88	85	Cotton cloths	26	24
Boards, planks	81	57	Crude oil	23	18
Cotton cloth	79	85	Cigarettes	23	24
Fruits	67	74	Milk, canned	22	19

Leading Seller of Distilled Liquid. Not only is the United States the world's biggest buyer of crude oil but it is also the most successful seller of refined products. In 1923, according to the Department of Commerce (page 191), our country supplied almost 31 percent of all the petroleum products consumed throughout the rest of the world. For the first time in about 10 years the *quantity* of all kinds of mineral oil exported practically equalled that of the imports. Since the imports were 82 percent crude and the exports 82 percent refined for 1923, a big balance *in value* is found in favor of the exports. This balance amounted to nearly \$256,000,000 in 1922, and to \$288,000,000 in 1923.

EXPORTS OF MINERAL OIL DURING THE CALENDAR YEARS 1922, 1923 AND 1924

Articles	Million Barrels			Million Dollars		
	1922	1923	1924	1922	1923	1924
Gasoline, naphtha, etc.	13.8	20.1	28.3	\$126.8	\$137.7	\$167
Kerosene	21.3	20.2	21.4	83.1	76.6	88
Lubricating oil	7.9	8.3	9.1	76.6	76.7	86
Gas and fuel oil	16.6	29.3	34.7	26.0	35.7	50
Crude oil	10.0	17.0	18.1	18.3	23.1	26
Totals	69.6	94.9	111.6	\$330.8	\$349.8	\$417
Percent refined oil	85.7	82.1	83.8	94.5	93.4	93.8

Solid forms	M short tons		Values, millions		Ave. 2 years
	1922	1923	1922	1923	
Lubricating greases	29.0	37.6	\$ 3.1	\$ 4.0	3.6
Paraffine wax	142.3	164.9	9.4	11.4	10.4
Asphalt and bitumen	66.0	95.3	1.7	2.5	2.1
Totals solids	237.3	297.8	\$14.2	\$17.9	\$16.1

EXPORT DISTRIBUTION CHART

FOREIGN COMMERCE DEPARTMENT, CHAMBER OF COMMERCE OF THE UNITED STATES



Largest Values in Light Oils. The lighter distillates, gasoline, naphtha, etc., constituted 39 percent of the total value of refined petroleum exported

during the two years, 1922-1923. Adding thereto the value of the kerosene sold abroad, the total value of light oil exports exclusive of lubricating oil, made 62.4 percent of the value and 46 percent of the volume of the liquid petroleum exports during these two years. Foreign markets for illuminants and lubricants are quite stable, but the demand for motor fuel is growing rapidly in agreement with the gain in sales abroad of American autos and trucks. Domestic overproduction, more than any other cause, accounted for the great increase in shipments of gas and fuel oil, the volume of which, 31 percent of practically 4,000,000,000 gallons, exceeded even that of kerosene in 1923. This is verified by the fall in unit value of the fuel and gas oil exported, from 3.7 cents per gallon in 1922 and 2.9 cents in 1923, or almost 22 percent. Excessive output also affected the average export price of gasoline, naptha, etc. This dropped from 22 cents in 1922 to 16.7 cents in 1923, at the point of exportation.

Recent Expansion in Export Trade.* The rapid rise in gasoline shipments to foreign countries has been indicated on page 109, up to the end of 1922. The *gain* for the calendar year 1924 over 1923 was 340,000,000 gallons and for 1923 over 1922 was 266,000,000 gallons. The increase registered in two years thus totaled 609,000,000 gallons or 14.5 million barrels. This great gain was 105 percent of the actual gasoline exports during 1922. Such an enormous growth in two years has been unparalleled in history. It was due partly to better conditions abroad and partly to excessive supplies at home. The increase for 1925 was about 100,000,000 gallons, or nearly 9 percent of the gasoline exports in 1924.

Shipments Abroad in 1925. Petroleum exports, exclusive of medicinal oils and similar products, declined in total quantity but increased in value to \$471,000,000, which made 9.6 percent of all merchandise exports in 1925. The decrease in quantity was entirely due to a reduction of 4.5 million barrels in crude shipments. The refined oil total was but slightly higher in 1925, as shown in the comparative figures below:

UNITED STATES EXPORTS OF PETROLEUM AND PRODUCTS

(In millions of gallons, according to U. S. Commerce Reports, Feb. 15, 1926)

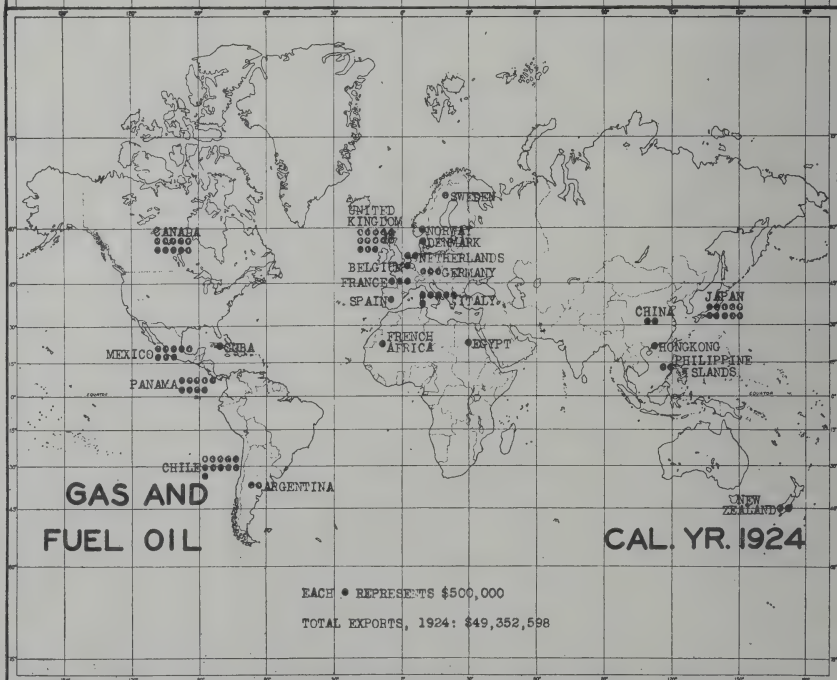
Product	1924	1925	Product	1924	1925
Refined oil, total.....	3,922	3,938	Crude oil.....	739	551
Gasoline, etc.....	1,186	1,290	Residuum, etc.....	2.8	4
Kerosene.....	917	877	Petrol. asphalt (tons).....	..	.08
Gas and fuel oil.....	1,440	1,368	Lubr. greases (lbs.).....	95	98
Lubricating oil.....	379	403	Paraffin wax (lbs.).....	383	334

America Lubricates the World's Machinery. The entire earth depends upon the United States to grease the machinery of industry, agriculture and commerce. We sell abroad relatively more of our lubricants, from axle grease to airplane oil, than the gasoline which we produce. Normally we can spare one-third of our lubricants but no more than one-ninth percent of our output of motor fuel. The table herewith brings out two interesting acts: (1) Both output and export of lubricating oils are stabilized; and (2) the percent of the product exported has a small range. Converted into barrels of 42 gallons each the 7-year totals become 162.5

* Total exports of mineral oil during the 20 years 1903-1922 approximate 954 million barrels or 18 percent of the domestic production. They increased from 22.3 million barrels in 1903 to nearly 70 millions in 1922, or 204 percent compared with 455 percent increase in production. For the geographic distribution of petroleum exports in 1924 see world maps made by the Chamber of Commerce of the U. S. and reproduced in this chapter.

EXPORT DISTRIBUTION CHART

FOREIGN COMMERCE DEPARTMENT, CHAMBER OF COMMERCE OF THE UNITED STATES



million production, 55 million exports and the percentage practically the same as in the year 1921.



CHINA OUR CHIEF MARKET FOR KEROSENE

Uncle Sam supplies most of this illuminant through such exporting concerns as the Standard Oil Co. of New York, the Standard of New Jersey, The Texas Co. Standard Oil Co. of California, and the Union Oil Co. of California. This is a view of Texaco case oil being discharged at Dairen, Manchuria.

—The Texaco Star.

"THE DARK CONTINENT" IS ILLUMINATED WITH AMERICAN KEROSENE

Donkeys deliver the goods, case oil in 10-gallon tins packed two in a box. This scene is laid at Port Elizabeth, South Africa, and shows native porters near The Texas Co.'s stores.

—The Texaco Star.



THE PHILIPPINES MUST IMPORT ALL PETROLEUM PRODUCTS

After spending \$1,000,000, Standard Oil of California failed to find a commercial deposit of mineral oil in this part of the Malay archipelago. Borneo and Sumatra yield oil, and possibly some day the Philippines may likewise become a producer.

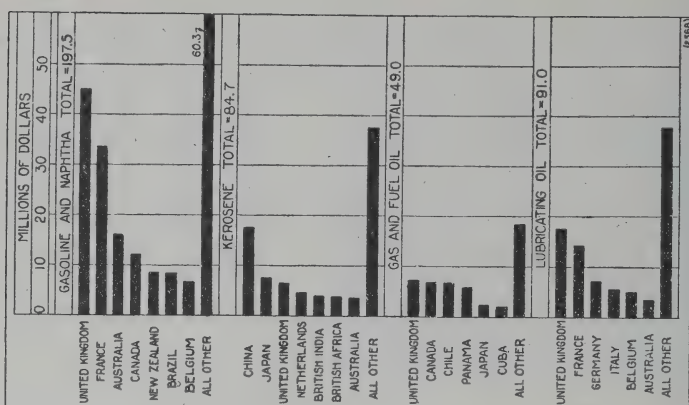
—The Texaco Star.

LUBRICATING OIL PRODUCED AND EXPORTED 1918-1923

(Millions of Gallons)

Year	Output	Export*	Pct.	Year	Output	Export	Pct.
1918	841.5	259.0	30.8	1922	972.8	331.4	34.1
1919	846.8	277.1	32.9	1923	1,097.4	345.4	31.7
1920	1,046.7	405.0	38.7	1924	1,154.9	382.0	33.0
1921	877.9	291.3	33.2				
Seven years					6,838.1	2,294.2	33.7

* Additional to lubricating grease.



DESTINATION OF THE FOUR CHIEF FORMS OF REFINED MINERAL OIL EXPORTED IN 1925

The United Kingdom led in 3, China in 1, while France was second in lubricating oil and motor fuel.

OUR BEST CUSTOMERS FOR CRUDE AND REFINED OILS

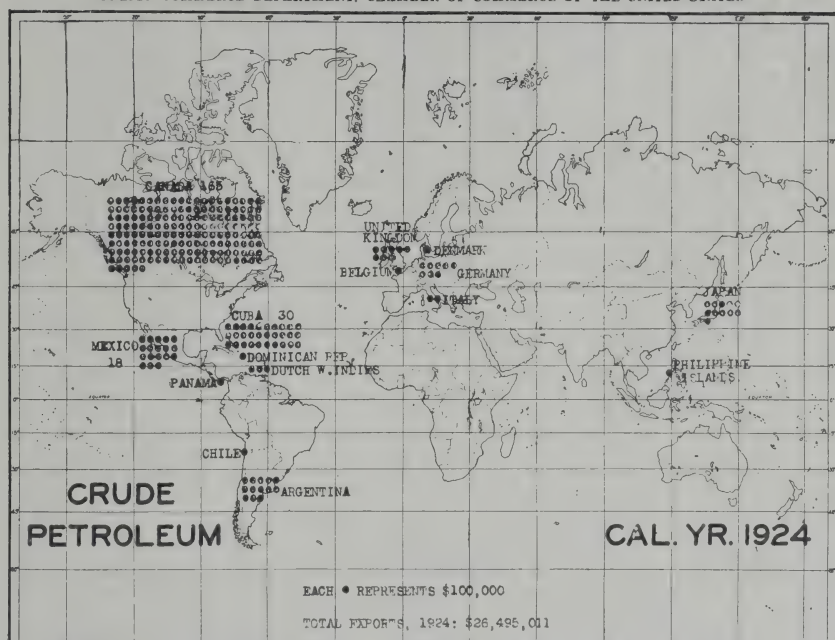
Great Geographic Range of Buyers. It has already been stated that American petroleum products, more than any other, have penetrated into the far corners of the globe. But while the distribution of such exports is very extensive it is not uniform since some customers need certain products more than others. Thus the United Kingdom took more lubricating oil in 1923 than France and Germany together, Canada more crude than all others combined, China more kerosene than any other three, and the United Kingdom and France together a little more gasoline than all the rest. Considering grand divisions, Europe is yet by far our best customer, but Latin-America—Cuba as well as South America—has lately made large gains in per capita consumption of our mineral oil. Germany was a huge consumer of American illuminating oil before the war. Now that the Dawes plan is operating, that country is getting back on her feet and reviving her petroleum trade. During 1924, due partly to increasing imports from Persia and partly to expansion in refining capacity, American participation in British imports began to fall off relatively.* Participation of the United States is more conspicuous in the oil import trade of other countries than Great Britain. Thus China gets 83 to 93 percent of her illuminating oil from this country; Canada, during the fiscal year ended March 31, 1924, got practically 100 percent of her gasoline imports and 70 percent of all petroleum imports from the United States; and in 1923, Germany obtained from us 72 percent of all her incoming mineral oil.

Gasoline, Naptha and Other Light Products. Of these exports France and the United Kingdom almost equally divided 52.8 percent in 1922 and 55.6 percent in 1923, referring to the total quantity. Canada, Italy, Australia, Belgium and Argentina brought the takings up to 73.2 and 77.6 percent respectively for these two years. The percentages according to value were slightly less—France, the United Kingdom, Australia and

* See *U. S. Commerce Reports*, May 19, May 26, and July 7, 1924; "Expect Larger European Oil Demand," by L. M. Fanning in *The Oil and Gas Journal*, August 28, 1924. New developments abroad naturally bears upon the export business of the United States. See *U. S. Commerce Reports*, January 28, 1924; "A Review of Petroleum Development Abroad in 1923," by Homer Fox, then acting chief, Petroleum Division; also, by the same authority, "World Trade in Gasoline," July, 1925; sold by the Supt. of Documents, Washington, D. C., at 15 cents.

EXPORT DISTRIBUTION CHART

FOREIGN COMMERCE DEPARTMENT, CHAMBER OF COMMERCE OF THE UNITED STATES



Canada acquiring together 61.6 percent in 1922 and 64.7 percent in 1923. Illuminating Oil. China averaged 17.4 percent of the quantity and 22.2

percent of the value of our exports of kerosene in 1922 and 1923. Second came the United Kingdom with percentages of 14.3 and practically 10, respectively, of the quantity and the value. The three next best customers for American kerosene were France, Netherlands and British India.

Lubricating Oil. Naturally, the industrially developed nations of Europe need lubrication for their machinery, whether on land or sea. Exclusive of the lubricating greases, in 1923 the United Kingdom took 25 percent, France 15.3, Germany 6.6, Italy 5.7, and Belgium 5.1 percent of our exports. Japan and Australia ranked respectively 6th and 7th in importing anti-friction oil from the United States. In 1922 Germany had taken 12.5 percent compared with 17.2 percent for France and 22 percent for the United Kingdom.

Gas and Fuel Oil. In harmony with her growing imports of crude oil for home refining, the United Kingdom took only 15.4 percent of these heavy oil exports from the United States in 1923 compared with 25 percent in 1922. Panama, undoubtedly on account of the bunker demand, led the other importers in 1923. Canada was a close third with 12.2 percent in 1923 and 15 percent in 1922. Chili, Mexico (West Coast), Italy, Japan, Germany, France and Argentina bought from 2.6 down to 1.3 million dollars worth of American gas and fuel oil in 1923.

Unrefined Oil. Canada, for a long time, has been our best buyer of crude oil, absorbing 56 percent of our export surplus in 1923 and 76 percent in 1922. Mexico suddenly increased her takings from next to nothing in 1922 to 36 percent in 1923. They consisted of California light crude to replace her losses in refinable oil for her domestic stills. Argentina took a trifle over 4 percent—about \$1,000,000 worth—or twelve times as much as in 1922. Cuba cut down her imports of our crude from \$2,343,000 in 1922 to \$855,000 in 1923.

LEADING EXPORTS OF LIQUID PETROLEUM FROM THE UNITED STATES IN 1923
ACCORDING TO IMPORTANT DESTINATIONS (Values in Millions of Dollars)

Receiving country	Crude oil	Gas and fuel oil	Lubricating oil	Illuminating oil	Gasoline, etc.	Total of all oils
United Kingdom		\$5.5	\$17.6	\$ 5.9	\$35.6	\$64.6
France		1.4	11.8	5.2	32.0	50.4
Canada	\$13.0	4.4	2.5	.5	7.3	27.7
China .....		.8	1.4	17.0	.6	19.8
Australia			3.2	3.6	9.0	15.8
Argentina	1.0	1.3	2.6	2.2	6.8	13.9
Italy		1.8	4.4	1.6	5.3	13.1
Germany .....	.7	1.5	5.1	1.5	2.3	11.1
Belgium .....		.4	3.9	1.6	5.0	10.9
Japan .....	.5	1.6	3.3	3.1	1.9	10.4
Brazil .....		.2	1.9	3.5	3.7	9.3
Mexico	4.7	2.1	.8	....	.5	8.1
Netherlands .....		.8	.9	3.3	1.6	6.6
British India .....		....	2.6	3.8	....	6.4
British Africa South .....		....	1.2	2.6	2.6	6.4
Panama		4.9	....	....	.6	5.5
New Zealand .....		....	.7	.5	4.0	5.2
Sweden .....		.4	1.0	1.0	2.8	5.2
Denmark .....		.9	1.0	1.2	1.7	4.8
Spain .....		....	1.7	....	2.7	4.4
Philippines .....		.8	.6	1.6	1.2	4.2

Compiled by the author from data published by the Department of Commerce.

Relation of Exports to Domestic Production. In 1923 and 1924 our exports bore about the same ratio to our production that our imports bore to our consumption considering the quantity of crude oil. (See page ...) The actual exports were 94.9 (and 111.3) million barrels and the production, 733.3 (718) millions*; the imports 99.5 (and 94.5) millions and the domestic

* Including amount produced for consumption on leases and not entering trade channels.

consumption 588 (and 612.3) million barrels.† The exports therefore made 12.8 percent (and 15.5) of our total domestic yield of crude oil. In detail the *percentages* of refined exports were of the refined products as follows: Gasoline, 9.6 in 1922, 11.5 in 1923, and 13.6 in 1924; kerosene, 39.8 in 1922, 36.3 in 1923, and 36.4 in 1924; lubricating oil, 34.1 in 1922, 31.7 in 1923, and 33.0 in 1924; gas and fuel oil, 7.2 in 1922, 11.6 in 1923, and 11.7 in 1924.

Exportation Not Necessarily Depletion of the Natural Resource. The impression prevails in some quarters that we are robbing our nation of its natural resources in order to increase our huge and superfluous reserves in gold (over \$4,500,000,000 on September 1, 1924). From one viewpoint, this is not true in regard to petroleum which, admittedly, is one of the two most evanescent of our natural resources. During the past 10 years we have actually imported more mineral oil than we have exported, measured in quantity. Even in 1923, the year of our greatest overproduction, our imports of both crude and refined oil exceeded the exports by almost 5,000,000 barrels. (See "Recent Expansion in Export Trade," page 181.)



—The Texaco Star.

EXPORTS SCATTERED EVERYWHERE; SCANDINAVIA GETS HER SHARE

Station of Wahlunds Mineralolje Aktiebolag, at Stockholm. The Texas Company's splendid financial record is partly the result of the successful operation of its highly organized foreign sales department. The American share in the Scandinavian oil market continues to form about 85 percent of the total consumption in the three countries. (See U. S. Commerce Reports, March, 1926.)

PETROLEUM TRADE OF THE UNITED KINGDOM IN 1924*

The magnitude of Great Britain's petroleum trade, and its dependence upon foreign sources of supply, are apparent from the fact that it paid out more than \$185,000,000 for mineral oil and its products during 1924. The quantity imported approximated 1,800 million gallons (American measure) or 42 million barrels. The exports in 1924 exceeded 125,000,000 gallons or 3,000,000 barrels valued at more than \$14,000,000 dollars. The re-exports amount to less than 70,000,000 gallons or hardly 1 2/3 million barrels of the declared value of 12 2/3 million dollars. The increase in imports since 1921 was about 83 percent (see page 17).

† Exclusive of 37.6 million barrels of bunker oil laden on vessels engaged in foreign trade. In calculating the percentages of the exports the shipments to insular possessions are included. The source of data is a bulletin of April 3, 1925, issued by the American Petroleum Institute, in turn based upon Government statistics.

* Almost entirely abstracted from Commerce Reports of January, 1925 (U. S. Consul C. L. DeVault of London).

Crude Oil Imports. These totaled $12\frac{1}{2}$ million barrels for the 12-month period, a gain of over 30 percent in one year or more than 100 percent in two years. Most of the huge increase came from Persia, which in October 1924, supplied over 37.1 million gallons compared with 11.3 million gallons from Curaçao (Venezuela), 6 millions from Texas ports, and small shipments from New York City. The imports of crude oil have grown enormously since the establishment of the large Anglo-Persian refineries at Llandarcy, Wales, and at Grangemouth, Scotland. Consequently, there has come a drop in the receipts of foreign refined products with but two exceptions.*

Increase in Imports of Gasoline. The multiplying of motor-driven vehicles has upheld the growth in gasoline imports. The increase over 1923 amounted to more than 115 million gallons. The imports during October, 1924, were at the annual rate of almost 500 million gallons or $12\frac{3}{4}$ million barrels. This rate would allow nearly 390 gallons to each vehicle registered in use as of August 31, 1924. On that date the motor-driven vehicles numbered 1,266,416, of which 495,579 were motor cycles. There were 160,000 more gasoline-propelled vehicles than a year before.

Growing Use of Fuel Oil. More than 11 million barrels of fuel oil were shipped into Great Britain during 1924, being a small increase in one year but a slight decrease in 2 years. Evidently the refineries cannot yet satisfy the increasing consumption not only in commercial and naval vessels but also in locomotives and industrial plants. During the 12 months ended July 1, 1924, 45 vessels of 242,162 tons—27 percent of the tonnage of new vessels—were fitted for oil burners. The total tonnage recorded on July 1 as oil burning was 17,154,072 in 1924, 15,792,418 in 1923, 9,359,334 in 1920 and 1,310,209 in 1914. Many large office and business buildings in London have lately installed plants for heating with oil.

British Coal Has Found Oil a Sharp Competitor. The shifting to oil bunkering is one cause of the British coal crisis, coal exports for bunkering in the North Sea, the Atlantic and the Mediterranean have fallen from 73,000,000 tons in 1913 to 45,000,000 at present. No wonder, since coal burning vessels now constitute but 64.8 percent of the world's tonnage compared with 88.4 percent in 1914, according to the London Bureau of *The Wall Street Journal*.

Less Buying Abroad of Gas, Illuminating, and Lubricating Oils. Kerosene receipts were off about 12 percent compared with 1923 and 25 percent compared with 1922. Lubricating oil on a large scale continues to come from the United States which is likewise the chief source of kerosene and gasoline. However, lubricants of all kinds are being produced on a large scale in the island kingdom. Gas oil imports fell off during the last part of 1924 compared with the corresponding periods of 1923 and 1922.

*According to Acting U. S. Com'l Attaché M. M. Mitchell, London. For complete figures for 1925 see *Petroleum Times* of London, quoted in *The Oil & Gas Jnl.*, Feb. 18, 1926, and *U. S. Commerce Reports*, March 8, 1926. Total British imports of 1,606.9 million imperial gallons in 1925 exceeded those in 1924 by 3 percent. The growth in the importation of crude oil (43 percent of which came from Persia and 20 percent from Venezuela) at the expense of refined products induced a drop in total value from 41.4 million pounds sterling in 1924 to 39.5 million in 1925. Receipts from the United States were 13 percent smaller in 1925.

BRITISH PETROLEUM TRADE IN 1925*

Importance to the United States. The United Kingdom has long been our largest single market abroad (see preceding table of foreign customers). The trend of British trade is, therefore, of particular interest to American petroleum exporters. Of our mineral oil exported during 1925, the United Kingdom took of the gasoline, 28 percent; paraffin wax, 27 percent; lubricating oils, 22 percent; fuel and gas oils, over 12 percent; kerosene, over 12 percent. In point of value British receipts of American petroleum approximates 80 to 90 million dollars or one-fifth of all our oil shipments to foreign lands. Rather disconcerting is the discovery that *both the total imports of refined oil and our share therein* dropped off during the period 1924-1925.

Lessening Significance of the United States as a Source. Imports from the United States decreased 13 percent and the American share in the individual products from non-British sources declined except in fuel oil, as follows: Kerosene (lamp oil), from 80 percent in 1924 to 58 percent in 1925; gas oil, from 93 percent to 80 percent; gasoline (motor spirit), from 76 percent to 47 percent; lubricating oil, from 86 percent to 85 percent; and crude oil, 1.6 percent in 1924 to even less in 1925. Apparently fuel oil fell off absolutely at least 100,000 barrels, although the Commerce Department reported a relative increase from 15.3 percent in 1924 to either 17 or 24 percent in 1925. Our sales to the United Kingdom were in the ascendency as a whole up to 1924 when the refineries at Swansea, Shellhaven and Grangemouth got into good swing. With growing receipts of crude oil from British owned wells in Persia and Venezuela (via Curacao in the Dutch West Indies), American exporters of refined products are now facing a steady reduction in sales to this island kingdom.

Value and Variety of All Oil Imports. Due to this recent drift in the "complexion" of the imports from "blonde" products to "brunette" crudes, the total value fell about 3.5 percent in 1925 from almost \$200,000,000 in 1924, notwithstanding the steady upward trend in total receipts, which were, roughly, 46 million barrels (of 42 American gallons) in 1925, compared with 45 millions in 1924, 38 millions in 1923 and 34.5 millions in 1922. Arranged in the quantitative order for 1925 the British imports of liquid forms of mineral oil were as follows, in millions of American gallons:

Product	1923	1924	1925	Product	1923	1924	1925
Crude oil.....	402	557	674	Lubricating oil.....	99	122	103
Gasoline.....	393	507	486	Gas oil.....	85	81	87
Fuel oil.....	436	463	401	Other refined oils....	3	5.2	7.5
Kerosene.....	173	150	170	All refined oils.....	1,189	1,328	1,254

Import Origins Other than the United States. While American shipments have generally made up more than half the British imports in value, in volume they have made less than half because of the insignificant contribution of crude oil. Other sources of imports are important only in single products or two as a rule. Thus Persia supplied of the crude 96.5 percent in 1923 and 82.7 percent in 1924; Mexico, 76.7 percent of the fuel oil in 1923 and 72 percent in 1924; Dutch Borneo, 16.6 percent of the gasoline in 1923 and 11.6 percent in 1924; Russia, displacing Mexico as the second source of kerosene, supplied 8 percent in 1925; but Mexico is still second in lubricating oil, furnishing 6 percent in 1925 to 5 percent from Russia.

* Abstracted from Trade Information Bulletin No. 407, U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, Julius Klein, Director, April, 1926.

Export Trade in Petroleum Products. With the operation of British refineries exports of products have risen at a higher rate than the imports of crude. The former increased about 120 percent from 90 million American gallons in 1923 to 200 millions in 1925; the latter, almost 70 percent from 400 million American gallons in 1923 to nearly 675 millions in 1925. The principal export was fuel oil with 101 million gallons in 1925. Second in quantity was gasoline with 61.5 millions; and third, kerosene, with nearly 25 million gallons. In addition to the exports of British refined products, about 75 million gallons of the imports were reexported, gasoline constituting the biggest item or 73 percent of the total.



—The Texaco Star.

BRITISH SALES STAFF OF AN AMERICAN OIL COMPANY IN SOUTH AFRICA

The silver cup was likely won in a cricket match.

WORLD CONSUMPTION FOR 1923*

Great Britain Second Greatest Consumer. The total consumption of petroleum and petroleum products throughout the world during 1923 amounted to over 38 billion gallons or 905 million barrels of 42 U. S. gallons. Of this, our country consumed 25 billion gallons or practically 600 million barrels. This made 66 percent of the world figure; but by adding the 1½ billion gallons of bunker oil shipped at United States ports for the use of vessels engaged in the foreign trade, the total became 70.2 percent. The next largest users were Great Britain and Russia, followed, in order, by Canada, France, Mexico, British India and Argentina. The consumption in these seven countries ranged from 3.9 percent in Great Britain down to 1.2 percent in Argentina.

Inventory Changes Ignored. In reaching these estimates, domestic production plus imports minus exports has been taken to indicate consumption. No account of changes in stocks have been taken except in the figures for

the United States, Mexico, and Rumania, since accurate inventories are not available for most countries. Where official statistics for 1923 were unobtainable, unofficial figures from the most reliable sources at hand were consulted. Conversions were made to American gallons for comparative purposes and crude production statistics added to show the relation between production and consumption in the various countries.

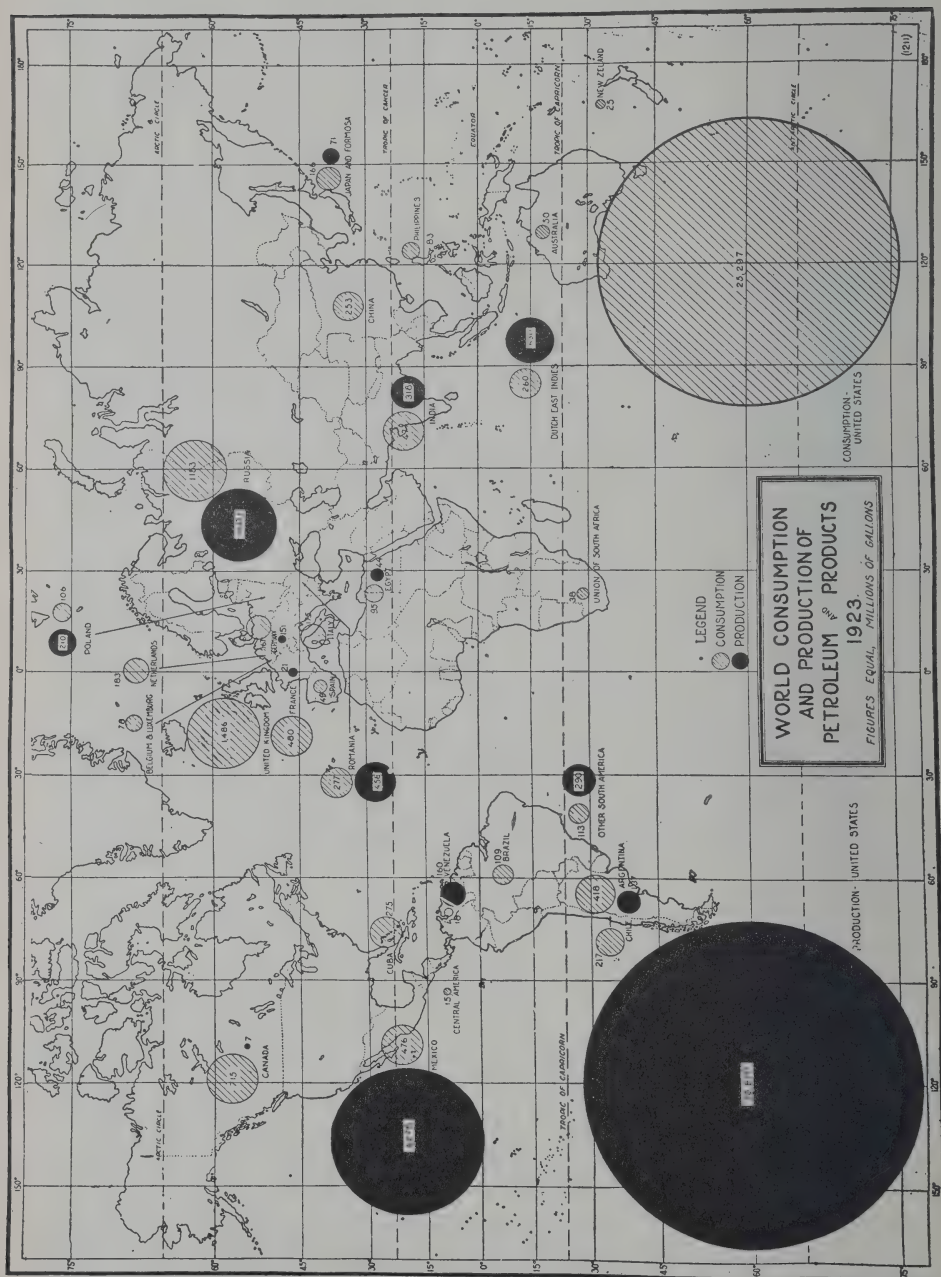
Domestic Production and Exportation. Only four out of the 16 largest consumers outside of the United States, namely, Russia, Mexico, Rumania and the Dutch East Indies, produce enough oil to meet local demands and leave a surplus for export; while only three of the remaining 12 have sufficient output to fill any important part of domestic requirements. These three are Argentina, Japan, and India. The United States had an excess of production over consumption in 1923, but the increase in stocks nearly absorbed this excess. The noteworthy result was that *almost the entire export trade and bunker oil supplied to vessels in foreign trade was provided by imports*. American refineries supplied the rest of the world with more than 3 billion gallons (practically 75 million barrels) of petroleum products in addition to crude shipments to make a total of 4 billion gallons (95 million barrels), or 30.8 percent of the estimated total consumption outside of our country. In other words, the Old World except as noted, Canada, and much of South America would suffer serious want were it not for the intensive development of the oil resources in the two major republics of North America. (See map on page 18.)*

ESTIMATED WORLD CONSUMPTION OF PETROLEUM AND PRODUCTS IN 1923 †

Geographic division	Population, millions	Millions of gallons		Consumption per capita
		Production	Consumption	
United Kingdom	47.3	....	1,486	31.4
Russia	93.4	1,603	1,153	12.3
Dominion of Canada	8.8	7	715	81.5
France	39.4	21	480	12.2
Mexico	15.5	6,278	476	30.7
British India	319.1	318	471	1.5
Argentina	9.0	137	418	46.4
Rumania	17.4	456	377	16.0
Republic of Cuba	2.9	0	275	95.1
Dutch East Indies	50.0	630	260	5.2
Republic of China	302.0	0	253	.8
Chili	3.8	0	217	57.7
Netherlands	6.8	0	183	26.8
Italy	37.5	1	175	4.7
Germany	39.9	15	167	2.8
Japan and Formosa	60.6	71	166	2.7
South America, unspecified	17.9	290	113	6.3
Brazil	30.6	0	109	3.6
Poland	27.8	210	106	3.8
Egypt	12.7	44	95	7.5
Philippines	10.4	0	83	8.0
Belgium and Luxemburg	7.7	0	78	10.7
Australia	5.4	0	50	9.2
Spain	20.8	0	49	2.4
Union of South Africa	6.9	0	38	5.5
New Zealand	1.2	0	25	20.3
Central America	5.8	0	15	2.6
Venezuela	2.4	160	18	7.5

* Adapted from *Commerce Reports*, September 8, 1924, H. S. Fox, petroleum specialist.

† Both the absolute and relative amount of refinable Mexican mineral oil have been decreasing, so that the United States may be regarded as generous to the importers of her refined oils since these products have been replaced with inferior crudes from across the Rio Grande. The percentage of American petroleum which fills the wants of foreign lands becomes 35 instead of 30.8 if the one and one-half billion gallons of bunker oil for ships in foreign trade be excluded from the total consumed outside of the United States.



CHAPTER X—LATIN AMERICA, LATENT AND PRODUCING INDUSTRIAL POSITION OF THE LATIN REPUBLICS

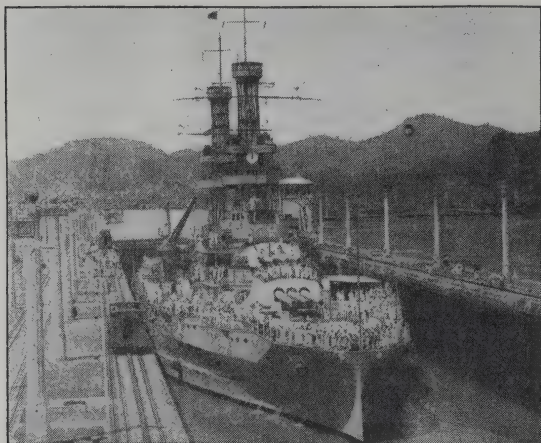
Leadership in Many Lines. Many North Americans erroneously look upon Latin America as a group of mere *manyana* lands. 'Tis true that the natural resources of this large region—17.5 percent of the earth's land area—are largely latent; and yet, the hundred million inhabitants—5.5 percent of the earth's total—appear to be quite happy and contented. Perhaps they plan to leave a little pioneering for posterity. Several causes have encouraged moderation in the rate of development—the tropical climate, the density of vegetation in humid parts, various other drawbacks to exploration, a small mileage of railways and of good highways, a scarcity of certain skilled labor and technical talent, and last but not least, the erratic treatment accorded foreign capital in some of these countries. Nevertheless, it is astonishing to stop and consider the long list of commodities treasured in international trade for which Europe, Canada and the United States depend upon Latin America as an important or even exclusive source of supply. Thus Cuba leads the world in sugar; Mexico, in silver; Central America, in bananas; Brazil, in coffee and black diamonds; Argentina, in quebracho, a tanning material, and Chili, in sodium nitrate. Practically all of the world's wild rubber is now obtained from Latin America. South America stands next to the United States in copper and next to the Straits Settlements in tin.

Ofttold Tales of Treasures and Tragedies. History and romance recount fascinating stories about the fabulous wealth of the Incas of Peru and the Aztecs of Mexico.† The cruel conquests by the Spaniards, however deplorable, opened up the treasure vaults of the vanquished which eventually led to the development of soil and oil by the overcrowded Europeans and their North American descendants. The Spaniards, however, overlooked the more useful minerals in their persistent search for gold, silver, and precious stones. It is startling to realize how the world's stocks of one metal—silver—have emanated largely from Latin America during the past four centuries. About 50 percent is even now coming from Mexico alone besides minor quantities from Bolivia, Peru and Chili. In contrast it may be noted that the world's gold has been accumulated mainly during the past three-fourths of a century in and from English-speaking lands, and then particularly from South Africa during the 20th century. World sources of the red metal, remarkable to relate, are now more than in the past, traceable to the two Americas, home of the copper-skins—90 percent in 1924.

Glory of Panama, Gateway For Gold in Days of Old.* Balboa's great discovery opened the way for the flow of wealth to Spain. In 1519 Panama, "The Place of Fish," was built on the Pacific coast. It was the first city founded by Europeans on the American continent. Here came great galleons, laden with gold and silver from the countries to the south. They

* While Chili and Peru produced together almost 15 percent of the world's copper, Latin America (including Mexico) as a whole is yielding as much of the red metal as Africa, Europe, Asia and Australia together.

† The reader is referred to Prescott's well-known histories.



U. S. BATTLESHIP TRAVERSING PANAMA CANAL

Not until this waterway had been open for eight years did the volume of petroleum traffic become noticeable. In 1922 California crude began to move to the Atlantic seaboard. During the fiscal year ended June 30, 1924, all forms of mineral oil made almost 51 percent of the 19,000,000 tons of eastbound cargoes.

were the precursors of the clipper-sails which carried gold and goods from California in the fifties and sixties of last century, and of the petroleum tankers loaded with liquid gold from later Golcondas. Over 250 years ago this second strongest citadel in Spanish-America was spoliated by the boldest buccaneer of the seas, the Welshman, Henry Morgan. Only a few arches and a broken tower now mark the overgrown site of the older Panama. The revolt of colonies over a hundred years ago and the California gold discovery by Marshall in 1848 resulted in the rebuilding and rejuvenation of Panama. In 1855 a railroad was completed across the isthmus—for a time the most profitable of all steam lines. Although the earliest settlers saw the eventual necessity of digging a ditch between the oceans the physical difficulties were too great for its attempt until modern machinery could be invented. It was the malarial condition rather than the financial troubles that prevented the French builder of the Suez Canal from accomplishing what General Goethals did with the help of General Gorgas. This famous sanitarian successfully fought the mosquito—and his main ammunition was mineral oil. When the Panama Canal was opened on August 15, 1914, nobody dreamt that eight or nine years later the leading toll-payer would be petroleum!*

United States Enterprise in Latin America.‡ Prior to the war, Europe led in the economic life, particularly in South America. Our American bankers and traders gained during the period 1914-1918. They met a temporary setback after the Armistice when every weapon of commerce was employed against them. Credit for a large share of our present success in overcoming European competition is due to the judicious investment of American capital and to the pioneer work of American engineers. However, long before the United States was able to export capital, its citizens were applying skill and ingenuity in building railways, establishing steam-

* See E. C. Brooks' "Stories of South America," Johnson Publishing Co., Richmond, 1922. See also Roger W. Babson's "The Future of South America," particularly pages 239-249, for unfavorable treatment of American capital.

‡ Abstract of address by Julius Klein, U. S. Dept. of Commerce.

ship lines, and opening coal and metal mines in South America. Thus, 72 years ago, Wm. Wheelwright, of Newburyport, Mass., planned the first railway and subsequently projected the first trans-Andean railroad. He established the first steamship line on the west coast of South America. Twenty years later Henry Meiggs performed the tremendous feat of constructing the highest standard-gauge railway in the world, the marvelous Central Railroad of Peru. The Panama Canal is the outstanding achievement of American engineering enterprise. There are other striking proofs of our ability and our interest in the development of the resources of Latin America such as its deposits of copper, iron, silver, tin and petroleum.

Only Three Share Well in World Trade. Since Latin America as a whole has poorly developed power resources (page 204), manufacturing has not advanced there as far as in those foreign countries that have applied their available energy in the form of either solid fuel or "white" coal. For this reason no nation south of the Rio Grande, with only two notable exceptions, rank high in both total world trade and in per capita commerce. These two, Argentina and Cuba, are agricultural countries which invariably have a huge surplus of certain products for export. Their mass production of these is related to their large imports of mineral fuel, particularly petroleum of which Argentina also obtains a considerable quantity at home. Brazil, which likewise ranks among the first twenty nations in the world trade, has only 1/7 the per capita commerce of Argentina and only 1/9 that of Cuba. This is owing to her large population (now nearly 32,000,000) and to her backward state of industrial development.*

FOREIGN COMMERCE OF LEADING COUNTRIES IN 1924 (Millions of Dollars)

United Kingdom	9,800	Holland	1,540	Denmark	755
United States	8,200	Italy	1,470	Brazil	735
France	4,275	Belgium	1,463	Austria	725
Germany	3,730	Argentina	1,440	Cuba	710
British India	1,990	Australia	1,250	Sweden	707
Canada	1,850	Czechoslovakia	970	China or Russia .....	.....
Japan	1,750	Switzerland	815		

UNITED STATES TRADE WITH LATIN AMERICA†

Position in Our Foreign Commerce. During 1924 all Latin America improved her position by commanding 22.2 percent of our entire foreign trade compared with 21.9 percent in 1923 and with 43.3 percent retained by Europe. Of our total imports of 3,610 million dollars in 1924, 29.4 percent came from the region to the south; of 3,793 millions in 1923, 27.8 percent came therefrom. In 1924, entire Europe supplied only 1 percent more than Latin America of our buying abroad; all Asia 3.6 percent less. As in our

* From "International Trade in 1924," U. S. Commerce Reports, June 1, 1925, J. J. Kral, Statistician.

All of the Latin American countries are in that stage of economic development where the energies of the people are chiefly devoted to the production of raw materials. A feature of their trade is the specialization of each region in one product and the consequent dependence of their prosperity upon foreign markets. Notable examples are wheat, wool and hides in the River Plate country; coffee in southern Brazil and the Caribbean region; wild rubber in the Amazon valley; cacao in Ecuador; Chili saltpeter in the Atacama desert; petroleum in Trinidad and northeastern Mexico; and bananas and coffee in Central America and the West Indies except Cuba.—U. S. Commerce Reports, Supplement 9, 1921.

† For more painful details see "Our World Trade in 1924," by C. D. Snow, For. Com. Dept. of the Chamber of Commerce of the United States; also "United States Trade with Latin America in 1924," by J. R. McKey, U. S. Dept. of Com. (10 cents, Supt. of Documents, Washington, D. C.)

petroleum trade with Latin America so our total exports thereto make a value much less than our imports therefrom. These were 770 million dollars against 1,060 millions, leaving a debit balance on our national ledger. Our exports to the south were 16.8 percent of all our 4,591 million dollars exports in 1924; 16.6 percent of 4,167 millions in 1923. Europe took 53 percent of our external sales in 1924, Asia 11.2 percent; in 1923, respectively 50.2 percent and 12.3 percent.

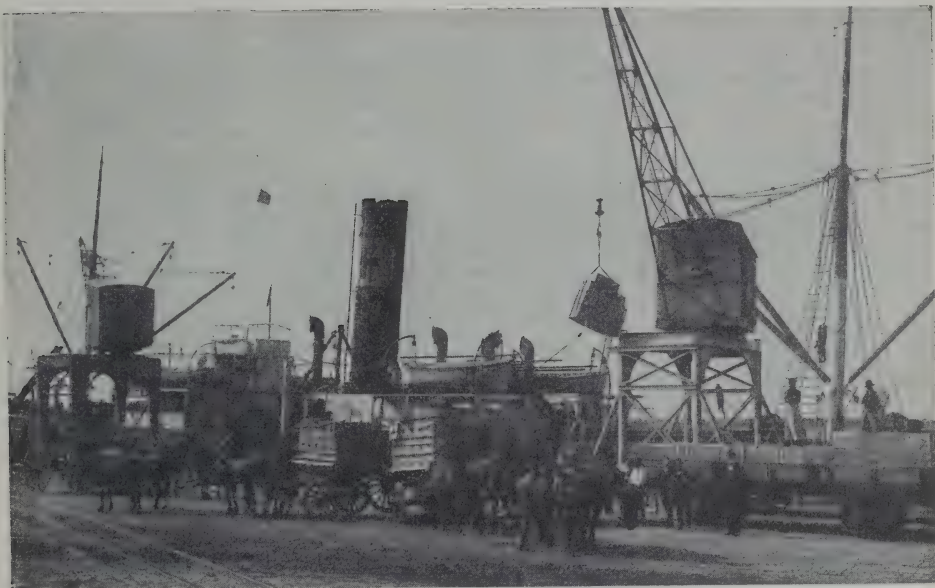
How the Separate Nations Stand. Some of the southern countries show up well in comparison with old world powers that deal with us, as indicated below. The figures refer to percentages of our export and import totals.

Our Fifteen Best Customers, 1924		Chief Sources of Supply	
1 Great Britain	21	1 Canada	11.1
2 Canada	13.6	2 Cuba (sugar 87%)	10
3 Germany	9.6	3 Japan	9.4
4 France	6.1	4 Great Britain	9.3
5 Japan	5.5	5 Brazil (coffee 88 %)	5
6 Cuba (cotton cloth 6.8%)	4.4	6 Mexico (crude oil 54.5%)	4.6
7 Italy	4.1	7 Straits Settlements	4.1
8 Holland	3.3	8 France	4.1
9 Mexico (refined oil 6.7%)	2.9	9 Germany	3.9
10 Australia	2.7	10 China	3.3
11 Argentina (farm machinery 14.4%) ..	2.5	11 British India	2.9
12 Belgium	2.5	12 Chili (sodium nitrate 48%)	2.7
13 China	2.4	13 Philippines	2.7
14 Spain	1.6	14 Argentina (flaxseed 32%)	2.1
15 Brazil (refined oil 19%)	1.4	15 Italy	2.1

We Buy More Than We Sell. From European nations we usually buy only half to one-third as much as we sell to them; but the reverse is true of Latin American countries. Thus Chili's exports of nearly 99 million dollars to the United States were actually more than 3 times as great as her purchases therefrom; those of Brazil, $2\frac{1}{4}$ times as much as her imports; Cuba's, $1\frac{4}{5}$ times; Mexico's, $1\frac{1}{4}$ times, and Colombia's, twice as much. Argentina, on the other hand, raising farm and range products of the temperate zone similar to our own, supplied us with goods worth only five-eighths as much as those received from us. It is therefore not surprising to note, in the second table above, that three Latin American nations were among the first six of our chief sources of supply. It is an astonishing statement, but true nevertheless, that all Latin America in 1924 bought barely five-sixths as much of us as Great Britain did—notwithstanding a ratio of 5 to 2 in total population. The contrasts in this triangular trade would be intensified if the United States were to refine all the crude oil to be shipped in the future from South America and were to dispose of the products to European customers.

Notable Changes in Our Trade. Latin American commerce with the United States in 1925 increased 5 percent to 1,920 million dollars or 2.4 times its value in 1914. The total exports and imports in 1924, 1,830 millions, was six times what it was in 1900. The nature of the trade has changed materially during a decade or two only in regard to great gains in nitrate and copper shipments from Chili, copper from Peru and crude oil from Mexico. Recent increased sales of wool, hides, linseed and quebracho to Europe from the River Platte region permitted Argentina, Uruguay and Paraguay to buy more automobiles and gasoline from the United States. Imports from Brazil climbed in 1924 to practically 180 million dollars, almost half as great as those from Cuba, caused by higher coffee prices. During last year we bought a less quantity of oil than in 1923 from Mexico; but its higher value and the higher values of winter

vegetables, lead, copper and silver made it possible for Mexico to purchase more automobiles, foodstuffs and mining machinery from us. Latin America (i. e., Mexico) still monopolizes exportation of mineral oil to our country, for all the rest of the world contributes less than 1 percent.



—The Texaco Star.

DISCHARGING AMERICAN CASE GOODS AT A SOUTH AMERICAN PORT

The docks here at Rosario, Argentina, like those at Rio de Janeiro and Santos, in Brazil, boast modern facilities for transferring cargoes of refined oils from the United States.

PETROLEUM AS A FACTOR IN OUR SOUTH AMERICAN TRADE†

Advancing Value of the Oil Trade. In South America's foreign commerce petroleum played but an unimportant rôle before the World War. Since 1913 it has become a potent factor in dealing with the United States and Mexico. The development of both production and consumption has variously influenced importation. Thus Colombia has been able, since 1922, to supply her own demands largely for petroleum products other than lubricants and paraffin wax. Nevertheless, our country has been enabled enormously to increase its sales of refined mineral oils throughout South America. In the largest country these now make nearly 20 percent of all our sales thereto, and in all South America 11 percent in 1923.‡

* The late increase in the trade between the United States and Latin America was due almost entirely to enlarged imports in the form of automobiles, gasoline and oil well supplies, as well as iron and steel, from the northern republic.

† M. M. Taylor in *Commerce Reports*, October 20, 1924; abstracted and supplemented by the author.

‡ According to J. R. McKey, Department of Commerce, petroleum products worth over \$64,000,000 made 7.3 per cent of our exports to all Latin America and ranked fourth, or next to iron and steel, cotton manufactures and automobiles in 1925. Among our imports during that year, \$75,400,000 worth of crude oil and \$30,700,000 worth of refined petroleum together constituted 10.2 per cent of all our Latin American imports ranking below coffee (26.7 per cent) and sugar (19.5 per cent).

Internal Trade Hitherto Trivial. Despite expansion in the production of Venezuela, Peru and Argentina,* the commerce in oil between South American countries remains relatively unimportant. Elsewhere natural barriers along political boundaries, i. e., transport difficulties encountered away from the coast, interfere with intra-national shipments. Peru provides Brazil with little or no petroleum, sending most of the crude (which makes two-thirds of all her oil exports) to the United States, Canada, Cuba, via the Panama Canal and to Argentina, around Cape Horn; also four-fifths of the raw naptha to Argentina and the United States,† the rest going to Europe. Venezuelan oil from Lake Maracaibo has to be re-shipped in ocean-going vessels from a Dutch West Indian island, Curaçao, where some of it is refined. The bar at the mouth of the Lake limits navigation to vessels of less than 11-foot draft.

South American Oil Imports More Valuable Than Exports. Contrary to the condition of our trade in general with Latin America (page ..) and in petroleum with Mexico, South American oil exports are still worth much less than oil imports. The reason is twofold: (1) Exportation in quantity has just commenced and (2) the receipts are mainly high-priced or refined products whereas the shipments consist chiefly of crude oil. In only two countries, as implied above, is the export phase more important than the other. The imports of all forms of petroleum from the United States were worth \$39,000,000 in 1924 and \$32,300,000 in 1923. As indicating a trend towards a better balance, the receipts in 1924 had a value only 10.4 times that of the shipments compared with 11 times in 1923. It will take a long time, however, for crude exports to equal refined imports.

RELATION OF PETROLEUM IMPORTS TO TOTAL IMPORTS FROM THE UNITED STATES (Values in Millions of Dollars; Percent Petroleum of Total Imports)

Country	Value		Percent		Country	Value		Percent	
	1923	1924	1923	1924		1923	1924	1923	1924
Argentina	\$14.2	\$18.2	12.6	11.3	Colombia	\$.43	\$.67	1.9	2.3
Brazil	9.5	12.6	21	19.4	Peru .....	.74	.66	3.7	2.8
Chili	3.9	7.6	12.5	24.0	Venezuela ....	.40	.51	3.3	2.9
Uruguay	2.7	3.2	18.	17.5	Rest of South America ...	.40	.46	3.7	3.5

The three "ABC" countries and Uruguay together took 14.7 percent of their imports (\$205,000,000) in 1923 and 15.8 percent (of \$232,000,000) in 1924 in the form of petroleum products; all South America 11.8 percent of the imports (\$270,000,000) in 1923, and 12.3 percent (of \$315,000,000) in 1924. The lower standard of living in five of the six other republics and in the three Guianas is reflected in the small per capita consumption made possible by their inconsequential imports of petroleum products. Outside of the "ABC" countries and Uruguay, South American imports of United States petroleum products made about 3 percent of the total imports in 1923 and 1924.

Reliance on Latin America For Liquid Fuel. The topnotch in oil production has been attained by the United States. Remarkable has been our ability to keep output at so high a level—50 to 70 million barrels monthly—for so long a time (since December, 1922). It would be simply miraculous for our producers to maintain the flood above the 700 million mark (70

* Argentina's output of almost 5 million barrels in 1924 filled but 40 percent of her domestic demand.

† Return cargoes from the United States consist almost exclusively of gasoline, kerosene, and other refined products.

percent of the world's output) after the end of 1927. Admittedly the spurt in the spring of 1925, due to the "cloud-burst" in Arkansas, meant very little to American motorists since Smackover oil is so very low in gasoline. A setback of 100-million barrels in 1927 should not be surprising. Until our immense shale oil deposits can be developed we must depend upon increasing imports. Upon what foreign sources may we count? Certainly not on Mexico for any increase, since imports thence have dropped 75 million barrels in four years. Can the rest of Latin America meet our emergency? Yes, in view of its huge resources and the present activity of highly organized American operators therein.



—Texaco Star

OFFICE STAFF OF AN AMERICAN OIL CO., AT KINGSTON, JAMAICA

Of \$23,000,000 United States exports to all British West Indies in 1925 fully 5 percent consisted of kerosene, gasoline, and other petroleum products including asphalt.

Present Interdependence of Pan-American Republics. Although South America is not yet as populous and productive as either Europe or Asia it surpasses both of these grand divisions in the number and degree of commodities supplied to the United States if the little of Latin America outside of South America be included with the latter for statistical purposes. It appears from the table below (for 1923) that the exclusiveness with which Latin America fills our need for nondomestic crude oil is no less formidable than, for instance, her ability to cater to our cravings for bananas, sugar, and coffee. Percentages for 1925 differ but little.

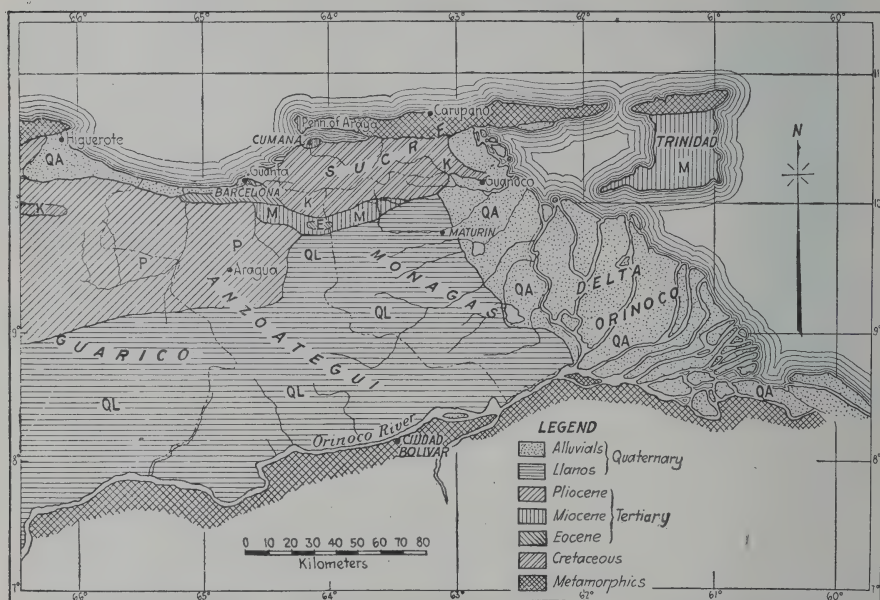
Commodity	From Latin America Millions	Per cent	Commodity	From Latin America Millions	Per cent
Bananas	\$ 19.7	99.9	ASPHALT	\$.98	90.5
Sugar*	349	99.5	Whale oil	1.90	90.0
Chicle	4.1	99.9	Bauxite ore .....	.52	87.4
Tin ore	2.15	99.2	Flaxseed	42.00	85.9
MINERAL OIL	78.	98.9	Lead ore	2.63	82.8
Quebracho	4.8	98.5	Copper	62.61	75.5
Coffee	186.	97.8	Fertilizers	44.4	69.4

* Philippine sugar considered non-foreign.

In return, Uncle Sam sends to Latin America 82.8 percent of his exports of butter; of his exports of cement, 93.3 percent, and of sugar-mill machinery, 79.6 percent. Of all explosives and ammunition shipped abroad, 67.2 percent goes to Latin America; of furniture, 62.4 percent; of eggs, 61 percent; of cotton manufactures, 58.4 percent; of agricultural machinery, 36 percent; of oil well machinery, 41.4 percent; of aircraft, 90 percent, and of petroleum products, 13 percent.

United States Imports of Crude Oil, 1924-1926. Unexpected upkeep of domestic production in the United States between 715 and 770 million barrels during the past four years and extensive application of the cracking process for gasoline manufacture have permitted a steady decline in the importation of petroleum, as shown in the following table wherein the figures represent millions of barrels of 42 United States gallons crude oil.

Source	1924	1925	1926	Source	1924	1925	1926
Mexico	74	55	40	Colombia .....	..	..	2
Venezuela	1.2	4.7	11	Peru, etc.	2.4	1.8	5



—Mining and Metallurgy

GEOLOGICAL MAP OF EASTERN VENEZUELA AND TRINIDAD

The close relationship of Trinidad to the mainland is clearly evidenced. The largest oil seepage in the world is Bermudez Lake, at Guanoco (see middle top of map).

DIFFERENCES IN ECONOMIC AND GEOLOGIC CONDITIONS

Natural Conditions Not the Same in South America. American demand and American enterprise cannot alone account for the fact that the United States and Mexico have been the source of two-thirds of the world's 13,000 million barrels of oil produced to July 1, 1925. Scientific research, discoveries of new fields, and deeper drilling in the United States point to its possession of greater reserves than were estimated only two or three years ago (pages 19 and 39). Eventually it may be established that North America originally had much more than twice as much petroleum under-



**TYPICAL MUD
VOLCANO OF
EASTERN
VENEZUELA**

This one is located in the state of Monagas on the southwest side of the Gulf of Para, opposite Trinidad. Seepage of oil is associated with it. Similar gaseous volcanos occur along the Caribbean coast of Colombia.

ground as South America. It seems that there is more organic material in the sedimentary rocks here than in the region south of the Caribbean Sea (pages 22 and 23). One indication of this is the relative scarcity of coal in all Latin America. Partly offsetting this, Mexico has an immense thickness of organic limestone underlying its major oil fields. A greater stratigraphic range and wider extent of possible oil-bearing beds also characterize the North American continent. Nature has laid down additional unfavorable conditions for finding, extracting, and marketing mineral oil in South America. Mountain and swamp barriers interfere with transportation; the climate is not everywhere encouraging, especially in regard to humidity; and even where exudes are common the vegetation obscures the sight if not the smell of the oil.

Geological Occurrence of Latin American Oil. South American and Mexican oils occur almost wholly in strata of Tertiary and Cretaceous ages. These beds have been folded into oil-holding structures around Lake Maracaibo and in Colombia, but in Peru and Ecuador they are badly broken

**CRATER OF MUD
VOLCANO ON
TRINIDAD**

As on the mainland of South America, solfataric formations are associated with seepages of petroleum.



* In Northwest Peru and Southwest Ecuador the formations belong to an early Tertiary age. Alternating layers of clayey slate, sandstone, etc., compose the strata which rest on hardened sandstone of Cretaceous age. The oil-bearing beds are most tricky, being inclined, folded and even faulted to the extent of 1,000 feet or more.—T. I. Bulletin No. 178, January, 1924, U. S. Department of Commerce.

causing many dry wells to be drilled.* In the Comodoro Rivadavia field of southern Argentina the first traces of oil and asphalt are found in an upper Cretaceous bed of greenish and whitish sand and clay from 550 to 700 feet thick. The thick and almost flat stratum of heavy Tertiary clay above accounts for the lack of surface signs nearer than points 35 to 100 miles away. In the main fields of Mexico, near Tampico, the outstanding features are: (1) A tremendous thickness of the "mother rock," the Tamaspoco limestone; (2) association with volcanic necks and dikes; (3) innumerable seepages similar to those of eastern and northwestern Venezuela, and (4) unique underground condition of supposed cavernous storage and known hydrostatic pressure that in places permit a single well to drain an entire pool without pumping. Latin American petroleum comes from sources 200 to 3,000 feet deep, averaging less than 2,000 feet in 1925 compared with almost 3,000 in the United States.

Characteristics of the Crude Petroleum. The quality of the oil varies, but not so much as in the United States where there is a much greater range in depth as well as in the geological age of the oil horizons (see pages 26-28). The Mene Grande and Comodora Rivadavia oils of 18° and 18.5° B. are heavier than the average from the older California fields; La Rosa oil is a little heavier than the average Gulf Coast product (page 39); Las Infantas† is reported from 27° to 36°, and El Mene, 37°, so are similar to Mid-Continent average; Peruvian is the lightest and best, of mixed asphalt and paraffin base, that from Negritos and Lagunitas yielding 24 to 30 percent gasoline and naphtha and 25 to 34 percent kerosene with a lubricating fraction, thus comparing with the Pennsylvania grade of crude. The heaviest and most viscous oil is the asphaltic crude from the Panuco, Ebano and Topila fields of Mexico. It varies from 10° to 15° Baumé and is chiefly a fuel oil.

Labor Relations Not Always Ideal. Anarchistic agitation originating not entirely in the United States have made Mexican workmen dissatisfied with the relatively higher wage scale followed in the oil fields than in the rest of Mexico. Relations between employers and workers are not such as tend toward an increased efficiency of labor. Strikes have been frequent and there is considerable unrest among the labor element. Mexico is a country where continued development is still a factor in its prosperity, and undoubtedly the dampening effect of strikes and other labor disturbances react to lessen the flow of money available for new enterprises. The strike of August, 1924, was directed particularly at a Royal Dutch-Shell subsidiary (La Corona), but sympathetic strikers also forced the suspension of American operations near Tampico.* The strike of May-June, 1925, grew out of the struggle between rival unions and resulted in a number of murders. Among those killed was the native superintendent of a pipe-line system owned by a subsidiary of the Pan-American Petroleum and Transport Co. Like the attitude of governments, labor conditions generally in Latin America are best at the beginning of operations in the oil fields and up to the time that returns come in from the investments of foreign capital. Future industrial peace would benefit both employes and investors and

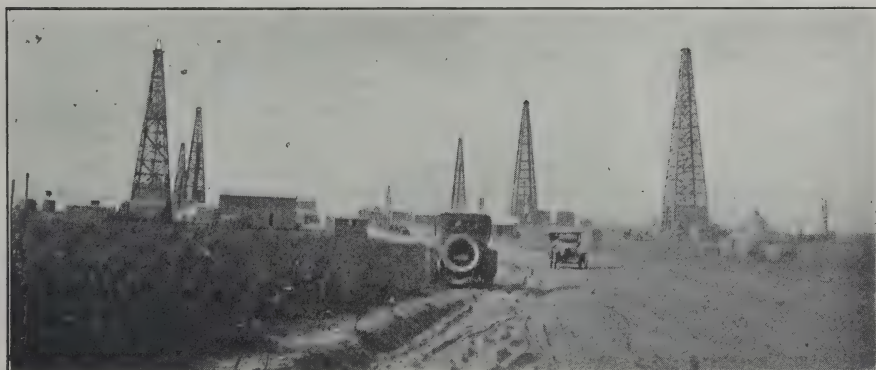
* R. A. Lundquist, a division chief, in the issue of May 18, 1925, *U. S. Commerce Reports*.

† The weighted average gravity of the oils produced from the Venezuelan fields (Mene Grande, La Rosa and El Mene) during 1924, as determined by the author, is 20.8° Baume or 0.5 more than the gravity of the oil from the discovery well at Smackover, Ark.

oil sold to foreign consumers. Decent and even liberal treatment of Latin American labor has always been the policy of American as well as British management of petroleum enterprises throughout the Western Hemisphere. Troubles have invariably been traced to parasitic interlopers.

Domestic Demand Limited by Road Development. The condition of the highways in Latin America are still a handicap to motorists. Out of 44,000 miles of roads in use early in 1925, only 12.6 percent were classed as good. About 20,000 miles were building or projected, according to U. S. Commerce Reports (April 6, 1925). How backward motoring must be is implied by the limited mileage for each of ten countries listed below. The first column figure shows the mileage of all roads (old, building and projected); the second indicates the percentage which the good roads made of the total in use, and the third the number of gallons of petroleum consumed.

Country	Miles of roads	Per cent good	Per capita demand	Country	Miles of roads	Per cent good	Per capita demand
Brazil	26,500	7.8	3.6	Colombia ..	2,500	37.6	3.
Mexico	12,000	7.5	30.7	Bolivia ...	2,460	11.7	?
Chili	3,400	9.8	57.7	Cuba	2,100	1.33	95.1
Peru	2,900	11.6	20.7	Argentina .	1,800 ?	40.6	46.4
Venezuela..	2,700	29.2	7.5	Ecuador ...	1,240	0	?



—The Lamp

TRINIDAD HAS GOOD ROADS; PRODUCES LIQUID OIL AS WELL AS ASPHALT

It is the only part of the British West Indies which sells more to the United States than it buys. The difference is due largely to Trinidad's exports of asphalt, motor fuel and crude oil. These were valued at over \$1,000,000 in 1925. The oil wells, in the southwest near the asphalt lake, give this island probably the highest yield of petroleum per capita and per square mile of total area in Latin America. About 30 percent of its 1,755 square miles are considered possibly oil-bearing.

Hardly any of our states have so few miles of highways, and none of them has so low a percentage of good roads as the average, 12.6 percent, for all the Latin American lands. The drier climate of Argentina accounts in large degree for her high percentage of good roads. In the case of Colombia and Venezuela, unquestionably the new roads built by the oil operators have helped to bring the percentage up. Tropical South America, notably Brazil, will not show a great increase in consumption of refined oils for some years because of the natural difficulties in the way of constructing and maintaining good roads. With hardly more than 150,000 cars and trucks in all South America, it is found that a single state, Iowa, which ranks only ninth in the Union, possesses four times as many. The table above plainly implies that current consumption of petroleum products is independent of rural road conditions and extent.

Other Reasons Which Retard the Opening of Oil Fields. Reference has already been made (on page 10) to the dubious attitude of the various Latin American states towards foreign capital which is eager to enter the oil regions. Aside from tax treatment and political turmoil, there are two outstanding reasons for the tardy development of the petroleum deposits south of Mexico. According to one authority* who returned early in 1924 after ten years abroad, these two reasons are the human element and the lack of efficient drilling machinery. This is more particularly true of European and Asiatic conditions where American drillers and American machinery are less well known than in Latin America. The writer would add also the climatic conditions, notably in Colombia and Venezuela.

DORMANCY OF COAL AND DAWN OF OIL DEVELOPMENT

South America's Deficiency in Coal Deposits.† The energy resources of South America are neither so well balanced nor so widely distributed as those of North America. Though the development of her large oil fields is encouraging and though the potential water power on the east flank of the Andes is enormous, South America has smaller coal resources than any other continent.‡ The contrast with North America is notoriously sharp. Mexico and Central America, however, have very limited deposits and yield less than 1,000,000 tons a year compared with more than 600,000,000 tons from the United States and Canada. Hitherto, Chili has been the chief source of solid mineral fuel mined in South America. The total annually obtained in all Latin America rarely runs over 2,500,000 tons, a quantity exceeded by 18 of the 30 coal states in the Union.

Coal Consumption Inconsiderable. Owing to the climate and the lack of large industrial development the annual consumption of the entire South American continent is no more than what Colorado could supply with her 10,000,000 tons a year. During 1924 Argentina imported almost 3,500,000 tons of coal, nearly 90 percent British, and Brazil about 1,500,000 tons, half from Great Britain and half from the United States. Cuba, the rest of the West Indies, Central America and Mexico took together almost 1,200,000 tons from the United States. To replace 10,000,000 tons of coal would require no more than 35,000,000 barrels of fuel oil or less than the expected output of crude in South America in 1925.

A Quickening in Oil Production. As evidencing the virginity of the oil resources south of Mexico, a study of the production tables on pages 14 and below, will bring out several surprising facts. The longest producing country in South America, Peru, in 30 years has contributed only 50,000,000 barrels or half of 1 percent to the world's total of about 14,500,000,000.

* L. R. McCollum, sales manager of the Titusville Iron Works, quoted in *The Oil and Gas Journal*, April 3, 1924.

† Partly abstracted from "World Atlas of Commercial Geography," U. S. G. S., 1921; read also "Coal Resources of the Americas," by B. L. Miller, of Lehigh University, published by The Pan American Union, 1923.

‡ According to the 12th International Geological Congress, the world's coal resources, as shown in 1913, were as follows (in millions of metric tons): Colombia, 27,000; Chili, 3,048; Peru, 2,039; the rest of South America, 10. Total, 32,097. United States, 3,838,657; Canada, 1,234,586; Mexico, Central America, etc., 505. Total North America, 5,073,431; Europe, 784,190; Asia, 1,279,586; Africa, 56,200; Australia, 165,572; New Zealand, 3,386; other islands, 1,452. Total Oceania, 170,410; total Eastern Hemisphere, 2,292,025; total Western Hemisphere, 5,105,528 (of which only 0.64 percent in South America); total world's reserve, 7,397,553 (of which only 0.43 percent in South America).

barrels to the end of 1926. By the end of 1927, Venezuela will rank ninth in accumulated output. Another truth, very surprising fact, relates to the large percentages which the output in 1926 and in the past five years made of each country's aggregate to the end of 1926. Of Venezuela's total production to the end of 1926, over 99 percent has been obtained in six years. Of Mexico's 1,450,000,000 barrels, 61 percent has been procured during the period 1921-26.

Included in the total for Latin American are the trivial quantities of crude oil obtained in Cuba and elsewhere. Recent as the development has been in Persia, where 65 percent of the output has been procured in four out of thirteen years, it has not been nearly so rapid as in Colombia, where all the output was obtained after 1920, and in Venezuela where 92 percent gushed forth in the same short period. That Mexico is not yet a minus factor is emphasized by that fact that more than 11 percent or almost one-ninth of its yield in twenty-four years flowed to the surface during 1924; also by the fact that 84 percent of all Latin American petroleum produced in 1924 came from that nearby republic.

The Outlook for the Future in Latin America. With four times as much credited to her as to all the rest of Latin America during the past four years (1923-1926), Mexico will likely remain the world's second producer of petroleum until 1929. But in Mexico production passed its peak (of nearly 200,000,000 barrels) in 1921; whereas in South America, notably in the northwestern end and in the republic of Peru, the mining of mineral oil is gaining momentum each year. By 1928 the yearly yield of Mexico should easily be equaled if not exceeded by that of the rest of Latin America. All Latin America may by 1930 have an annual rate of output half that of the United States.

OIL RESOURCES AND DEVELOPMENT OF MINOR COUNTRIES OF LATIN AMERICA

Cuba, Richer in Ore Than in Oil Reserves. While Cuba contains deposits of asphalt, copper, gold, manganese and mineral oil, they are not known



—The Texaco Star

THE CUBAN SUGAR INDUSTRY TAKES FUEL OIL FROM MEXICO AND THE UNITED STATES

Typical Cuban fuel-oil installation at a "Central" (plantation and mill). It is interesting to note that the bagasse or refuse from the mill is itself a source of liquid fuel (alcohol) and the fibrous part thereof can be made into the new building material, celotex.

to be important compared with the 3,200,000,000 tons of iron ore reserves* found chiefly in Oriente Province. Asphalt seeps and veins of oil and gas seeps have been reported from every province, mostly in broken serpentine within Cretaceous beds above Jurassic limestone.** They are most common on the north coast. In western Cuba alone the asphalt is considered proof of former large accumulations of oil, at least 20,000,000 barrels of which was evaporated or oxidized to leave the residue† From the wells at Bacurano, Province of Habana, about 4,000 barrels of oil are annually produced.‡ The per capita consumption (95 gallons, or $2\frac{1}{4}$ barrels, in 1923) the largest in Latin America although road conditions are not ideal. Outside of the United States, Cuba is one of the four best customers for Mexican crude oil. Our country is its principal source of refined products. We supplied \$6,200,000 worth in the fiscal year 1921-22.



—The Lamp

A unique model of this "World Wonder" may be seen in the General Asphalt Company's office at Philadelphia.

QUARRYING AND HAULING ASPHALT

The Trinidad asphalt lake of 115 acres is only 138 feet above sea-level but over 175 feet deep. Since 1888 it has supplied about 5,000,000 tons of asphalt for paving famous avenues in leading cities.



Trinidad Long Celebrated for Its Lake of Asphalt. This island, believed once to have been physically a part of eastern Venezuela, is an important producer within the British Empire. Its asphalt lake is situated a mile from the sea and covers over 100 acres. Oil production began in 1908, following the year in which Argentina entered the list. In all Latin America, Trinidad stood next to Mexico and Peru until 1922, when Argentina ad-

* Supplement No. 51, U. S. Commerce Reports, 1923.

** "Petroleum Reserves of the West Indies," A. H. Redfield, Am. Inst. Min. & Met. Engrs., 1922.

† *The Oil Trade Journal* of January, 1924, tells of the early (1899-1918) activities of Attorney Albert Wright, of later investigations by the geologists, Ralph Arnold and Barnabas Bryan, and of the developments conducted on the Bejucal-Madruga uplift by the Haskell-Owens interests.

‡ The concession at Bacuranao, Province of Habana, owned and operated by a local company, is the only active petroleum concession in Cuba producing crude. It has a progressively increasing production the past few years, amounting to 182,000 gallons in 1924. The crude is carried by a pipe line to Minas and there loaded into tank cars. A concession in the Province of Santa Clara has produced a very light oil requiring almost no refining for use as motor fuel.—Foreign Trade Notes No. 40, Department of Commerce.

vanced to third place. The greatest increase came in 1924 with a million more than the 3,050,000 barrels in the year before. The yield of 4,300,000 barrels in 1925 tied Trinidad with British North Borneo (Sarawak) for twelfth in world rank and third position in the British Empire, India being first. Most of the 60 wells active in 1923 are British owned and located in fields south of the lake. Most of the oil is topped and sent to British markets, but in 1925 about 65,000 barrels of gasoline was sent to the United States (the first such shipment having been made in 1924), besides 250,000 barrels of crude and 70,000 tons of asphalt.

Curacao Not Politically Part of Venezuela. It is a small island located northeast of the Gulf of Venezuela but not quite as close to the mainland as Trinidad. It is considered part of the Dutch West Indies although on the south side of the Caribbean. A Royal Dutch subsidiary operates a refinery on Curacao. The crude oil comes almost entirely from Venezuela, in low-draft vessels from Lake Maracaibo able to cross the 11-foot bar. In the last quarter of 1924 the imports amounted to 436,000 metric tons (about 3,000,000 barrels). Exports in the same period consisted of 267,000 tons of crude oil and about 161,400 tons of fuel oil shipped in the deep-sea tankers; also 973,000 gallons of gasoline, 388,000 gallons of kerosene, and minor amounts of Diesel oil, benzine, gas oil and distillate. Venezuela should be credited with practically all of the petroleum which trade papers state is coming from Curacao.

West Indies Otherwise Wanting in Oil. These islands, exclusive of Trinidad and Tobago, do not constitute a promising area of oil reserves. Most of the West Indies present unfavorable structure or composition. The smaller islands, excepting Barbados, are made up of late eruptive rocks or flat-lying Upper Tertiary sediments. Of the Greater Antilles, only Cuba and Haiti-San Domingo seem to be geologically built for the accumulation of commercial pools of oil.



AMERICANS TESTING FOR PETROLEUM IN PANAMA

—Texaco Star

The Carib Company's No. 1 Well, Camp and Crew near David, Chirique Province, in this Central American Republic. Up to 1927 no commercial discoveries had been made in Central America although oil seepages are encouraging.

Central America Not Promising in Petroleum. Nicaragua is notoriously volcanic so that recent lavas and tuffs conceal the underlying structure.

It is, however, possible that petroleum reserves are present. Guatemala and British Honduras are much better off, having jointly a broad zone of moderately disturbed Cretaceous and Tertiary sediments including bituminous beds. It resembles the belt of Central Texas, which takes in Luling, Mexia, and Powell; therefore it should be explored more thoroughly. Honduras has seepages, but its strata have been more violently bent, broken and intruded than those of British Honduras and is accordingly not considered so promising as the latter, or even as Costa Rica and Panama. In some respects the region northwest of the Canal is analogous to the southern California oil fields, which differ, however, in not containing igneous intrusions. The sediments of the California Valleys occupy wider areas and are more continuous than those of the coastal plain and foothills of Costa Rica and Panama.*

Ecuador Has Procrastinated in Petroleum Production. The presence of petroleum in Ecuador is mentioned as far back as 1700, but the year 1923 was the first in which there was any substantial production. By the middle of that year the daily yield had risen to 15,000 barrels. The chief company is the Anglo-Ecuadorian, a subsidiary of Lobitos Oil Fields operating in Peru. Much interest has been shown in the Santa Elena peninsula and in the Oriente region. Ecuador has three small refineries.†

Bolivia Badly Situated for Becoming a Big Producer. The oil deposits of this plateau region lie mostly east of the Cordilleras in a belt of seepages running from Argentina to central Bolivia. Near Santa Cruz oil is obtained from surface pools. Should oil be proven in commercial quantities there would still remain the problem of getting it to market. It must either be brought south by long pipe line to the nearest navigable river or north through the very difficult and little known territory to the Madera-Mamore Railway and thence to the Amazon.‡

THE THREE GREAT "A B C" COUNTRIES

Chili, the Champion Producer of Coal. This land belies its name for it needs but little fuel for heating. Most of the domestic coal and the imported oils are consumed by the copper and nitrate mines, the railways, and the industrial plants. While Chili is said to possess only one-ninth as large coal reserves as Colombia, it has been producing half of all the solid mineral fuel mined in South America. Lately, production thereof has declined ‡ so that the expansion of industry and commerce has in large measure come to depend on imported products of petroleum, fuel oil in particular. The receipts of such oil in 1924 from the United States alone, 4,800,000 barrels, was equivalent to 1,500,000 tons of coal, or as much of the latter as Chili ever produced in one year. This quantity was 2,200,000 barrels more than in 1923 when our shipments and those from Mexico amounted to 4,300,000 barrels together. Gasoline imports were less than 3 percent of the total value of all oil receipts from our country in either 1923 or 1924, which were respectively \$3,940,000 and \$7,560,000. Foreign capital is not fascinated with oil prospects in Chili and is leaving the wildcatting to local concerns. Eventually high grade oil from the Mendoza field in western

* A. H. Redfield, U. S. G. S., in *Mining and Metallurgy*, July, 1922.

† W. J. Archer in the *N. Y. Commercial*, March 31, 1924.

‡ According to *Commerce Reports*, July 6, 1925, has become demoralized because of competition with British and American coals and with American and Mexican fuel oil.

Argentina may be piped across the Andes, since this field is so high (6,600 feet above sea level) and is situated within 200 miles of Valparaiso and 150 miles of Santiago.*

Brazil Has the Biggest Unexplored Area. Brazil, although the leading manufacturing country of South America, has not developed a great source of fuel within its borders up to the present time. In 1922 Brazilian coal mines produced only about one-fifth of the 1,600,000 tons of coal consumed. Prospecting and test drillings for petroleum have not located any deposits of great importance. The country has immense resources of water power well distributed throughout the populated areas, but the utilization of this power on an extensive scale is more or less remote. Investigations have shown that the Brazilian shale oil deposits are not only rich but that they cover extensive areas, especially in Bahia, Sao Paulo, and the States to the south. It is thought that the hope of a future national fuel supply lies in the development of these shale oil deposits, and this presumably must be brought about largely by foreign capital.†

Refined Oil the Leading Import from the United States. The United States of Brazil, with a population of 32,000,000, imported in 1923 about 22,000,000 gallons of gasoline, 30,000,000 gallons of kerosene, 7,000,000 gallons of lubricating oil and grease, and 47,000,000 gallons of gas and fuel oils. As there is no local production and no refining of imported crude, these totals indicate the present annual demand. The United States supplies practically the entire petroleum market, except for fuel oil, the larger share of which is brought in from Mexico. Brazil is one of the most important South American consumers of refined petroleum, from the viewpoint of the American exporter, being second only to Argentina. In 1923 the United States exports of petroleum to Brazil were valued at more than \$9,500,000 and in 1924 at more than \$12,600,000. In the latter year 30,400,000 gallons of gasoline made up 47 percent of the total value; 26,400,000 gallons of kerosene, 33 percent; 7,100,000 gallons of lubricating oil, 15.8 percent.

Argentina Filling Two-Fifths of Her Home Demand. Despite the cheapness of draft animals, the use of tractors is growing, chiefly in breaking and plowing land and in road building. About 6,000 farm tractors were in use in Argentina at the middle of 1925; there would be more but for the high cost of motor fuel and oil. Consumption is greater, however, for autos, heating, lighting, industrial plants and railways not to mention the bunker demand. Per capita consumption had been higher than in other South American countries until 1924, when Chili passed the 50-gallon mark. Demand in 1923 was for 9,800,000 barrels, 35 percent of which was met with home production of heavy oil; and in 1924 it called for more than 11,500,000 barrels, 41 percent of which was supplied from domestic deposits.

Sources of Argentina's Imported Supply. Of the 1,100,000 barrels of gasoline bought from abroad in 1923, over 54 percent came from the

* For additional details read "Argentine Petroleum Industry and Trade," by G. S. Brady, Trade Information Bulletin No. 81; also "U. S. Trade With Latin America in 1924," by J. R. McKey and H. S. Giusta, T. I. B. No. 345, U. S. Department of Commerce.

† Director Julius Klein's introduction to "Petroleum in Brazil," by M. A. Cremer, T. I. B. No. 311, January, 1925, U. S. Department of Commerce, supplemented with statistics for 1924. See also "Oil Possibilities in Brazil," by the late J. C. Branner, in *Mining and Metallurgy*, June, 1922, American Institute Mining and Metallurgical Engineers. At one time a very active American held a concession of 13,000,000 acres in Santa Catarina.

THE HARBOR OF RIO DE JANEIRO

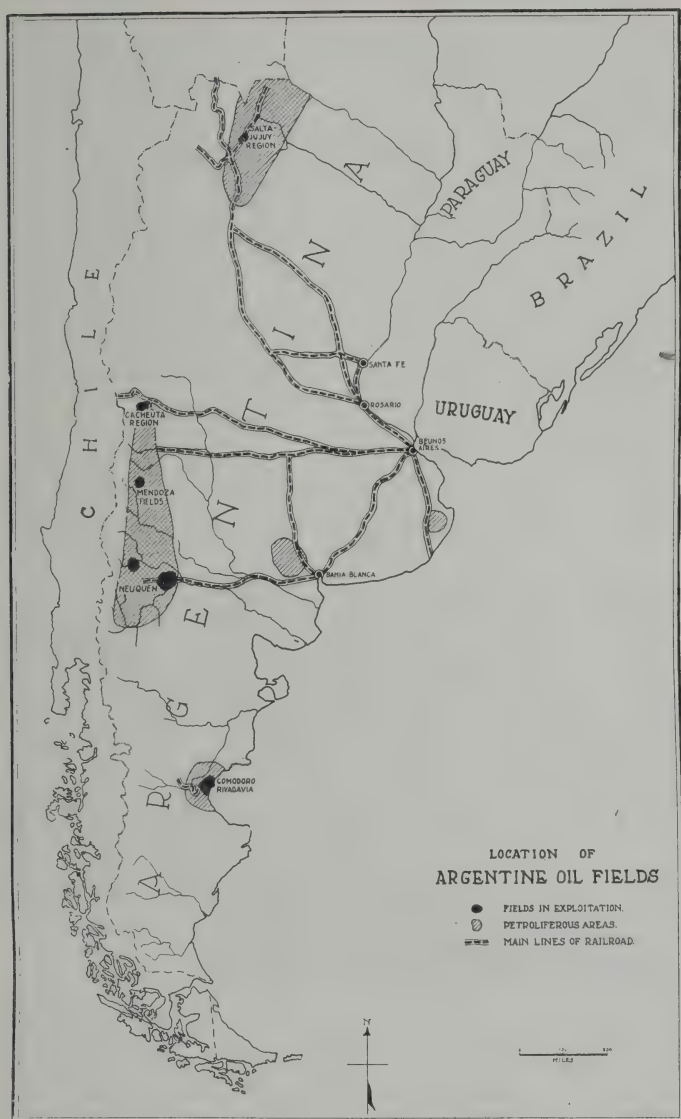
One of the five most famous natural harbors in the world. Much of the \$18,000,000 worth of petroleum products imported by Brazil in 1924 came to this port and to Santos. Of these imports, 70 percent were received from the United States. On the peninsula at the right was located the exposition commemorating the 100th anniversary of Brazil's independence.



COMODORO RIVADAVIA, A COSMOPOLITAN OIL CAMP

This field has been the source of over 98 percent of Argentina's domestic oil to date (1927). Petroleum of 16 to nearly 24 degrees. Baumé comes from 3 distinct formations in the Upper Cretaceous. Without cracking it yields less than 6 percent gasoline and naphtha and from 2 to 12 percent kerosene. Being so heavy it has been used, after topping, chiefly as fuel for the Argentine Navy.





ARGENTINA—THREE-FOURTHS A VAST PLAIN OF NEARLY FLAT MESOZOIC AND TERTIARY BEDS COVERED BY PLEISTOCENE GRAVEL AND GREAT FLOWS OF BASALTIC ROCKS

To the end of 1926 about 32,000,000 barrels of petroleum has been obtained from the folded cretaceous beds below the plain at Comodoro Rivadavia in Chubut territory; less than 1,000,000 from the Triassic, at Plaza Huincul, in Neuquen territory; and lately a little from the Jurassic or Cretaceous of the pre-Cordillera at El Quemada, in Jujuy Province. According to Redfield possibilities of future production appear to lie almost entirely in the Argentine plain and the relatively narrow belt of pre-Cordilleran ranges and valleys.

United States, over 23 percent from Peru and 21.2 percent from Mexico. In 1924, of 1,500,000 barrels, 42 percent came from our country, 25.6 percent from Mexico, and 31.3 percent from Peru. Our contribution of kerosene fell off slightly—from 78 percent of 61,800,000 gallons in 1923 to 73 percent of 64,700,000 gallons in 1924. Receipts of crude and fuel oil remained stationary, being 4,700,000 barrels in 1923 and 4,800,000 barrels in 1924, being almost evenly divided between Mexico and the United States, with a little crude in 1924 from Peru.

Development of Comodoro Rivadavia. This field is still practically the sole source of domestic petroleum (see map, page 211). It was accidentally discovered near the coast of southern and arid Argentina while boring for water in December, 1907, at a depth of 1,755 feet. Oil from Comodoro Rivadavia is heavy and asphaltic averaging a gravity of 18.5° Baumé. It is therefore heavier than Gulf Coast crude of Texas and yields very little kerosene and much less gasoline—from 12 to 20 percent of both. The area within a 15-mile radius of the discovery was declared a reservation and has since been developed exclusively by the Government. It turned out to be the best part of this coastal field. The output of 125,000 barrels in 1913 slightly exceeded that of the foregoing five years. Extraneous coal supplies for public utilities were cut off during the war and forced more rapid development. From 1,150,000 barrels in 1917 the yield increased to 1,750,000 barrels in 1921. Little Trinidad, beginning its own production in 1908, had led Argentina up to 1922 when the output of the latter reached 3,000,000 barrels. It rose from 3,400,000 in 1923 to 4,700,000 barrels in 1924, but was still less than half of 1 percent of the world's production and hardly one-thirtieth of Mexico's output the same year. In the last year 3,400,000 barrels came from Government wells, making 74 percent of the total from Comodoro Rivadavia.†



**LOADING PIER
FOR TANKERS
TAKING CRUDE
OIL FROM COMO-
DORO RIVA-
DAVIA**

The absence of natural harbors along the southern coast of Argentina at times make difficult the shipments to Buenos Ayres, 1,000 miles away.

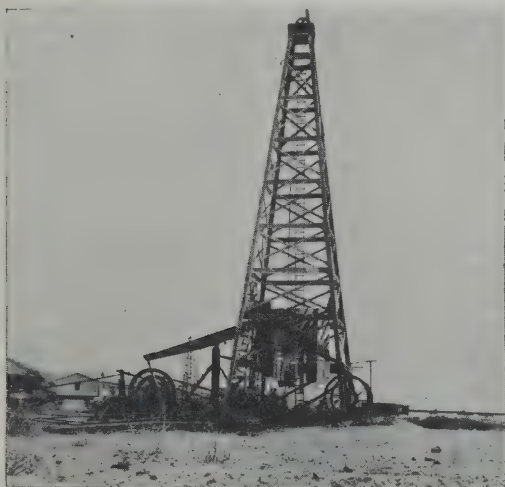
PERU HITHERTO THE PRINCIPAL PRODUCER

An Oldtimer in Oildom.* Spanish pioneers had dug ditches and shallow wells along the coast and had used the evaporated product as pitch for caulking boats and ships. Modern enterprise began in 1867 with the drilling of wells and the erection of a refinery by Prentice of Pennsylvania. The com-

† For description of the other Argentine fields see accompanying map.

* Read "The Ancient and Modern Oil Wells of Peru," in *The Lamp*, December, 1921; "Petroleum Industry and Trade of Peru and Ecuador," T. I. Bulletin 178, U. S. Department of Commerce; "Oil Exploration of Peru," *Bulletin of the Union Oil of California*, July, 1923; *The Rig and Reel Magazine*, June, 1923, and various papers by V. F. Marsters, in *Mining and Metallurgy*, American Institute of Mining and Metallurgical Engineers. Early in the 20th century W. L. Hardison, an associate of the late Lyman Stewart (see frontispiece) formed in Los Angeles a company composed of Gen. F. H. Flint, M. Whittier, C. W. Brown, et al. They got 41° oil in five wells 150 to 250 feet deep drilled at an elevation of about 13,000 feet in the world's highest oil field near Lake Titicaca.

pany which succeeded him at Zorritos produced in 1901 about 75,000 barrels of very light oil. This field has maintained its annual yield at that rate during the past decade. The foremost field, Negritos, was first developed in 1874 under the direction of Edgar Fowks, an American. One of the three wells then spouted from a depth of only 60 feet while another flowed 400 barrels daily from 330 feet. Herbert Tweddle began British operations here in 1888.† His company brought in its eighth well in 1899 at 545 feet and this continues to produce, thus evidencing the long life of wells in the Negritos field. More than ordinarily colorful is the story of operations carried on by Ed. L. Doheny, Sr., one of the most picturesque and powerful figures in American petroleum history. Thirty-one years ago, or six years before he pioneered Mexican petroleum, this Californian commenced drilling in Peru, but soon afterwards abandoned activities at Negritos because of unusual developments at home.



ZORRITOS, THE THIRD FIELD IN CURRENT YIELD IN PERU

The output of the 3 fields in 1926 approximated 11,000,000 bbls. About one-third was exported to the United States—over 3,600,000 bbls., valued at more than \$8,000,000 f. o. b. New York.

Negritos and Lobitos the Leading Sources. The small yield of the Restin field (106,000 barrels in 1921) is statistically included with the much larger yield of the nearby Lobitos field which is now second only to Negritos. The first attempt of a British company to find oil between Lobitos and Restin resulted in failure. Its wells, credited with 75,000 barrels in 1905, were taken over by the Lobitos Oilfields, Ltd., in 1908. This producer in 1924 got more than a million barrels from both fields which it controls. Standard of New Jersey indirectly owns the rest of Peru's production. Negritos is the source of 80 percent of the present output of Peru—almost 8,000,000 barrels in 1924 compared with 6,400,000 in 1923. The two principal sands vary in depth from 1,500 to 2,000 feet and from 2,600 to 3,000 feet. The quality of the oil is far superior to that of the La Rosa field in Venezuela, but the huge potential yield of the latter will likely permit it to

† Tweddle is said to have discovered the great Baku field in Russia. A son of William Keswick is still identified with the development although his original company, the London and Pacific Petroleum Company, together with two other operators were absorbed in 1914 by the Canadian branch of the Standard Oil Company of New Jersey (Imperial Oil through the International Petroleum).

surpass Negritos in 1925. However, it is claimed that the richest of all oil areas in Peru lies in the little explored "montaña" region east of the Andes.

Peruvian Trade in Petroleum. The import trade of both Ecuador and Peru is unattractive to the United States for two reasons: (1) Of the combined population of about 6,000,000, some 90 percent consist of Indians and "mestizos" whose purchasing power is next to nothing, thus differing radically from Argentina; and (2) the domestic output of oil, particularly in Peru is of such high quality and large quantity that the five refineries in the two countries supply nearly all the local demand for gasoline and kerosene. Thus in 1924 Peruvian imports of petroleum products from the United States amounted to less than two-thirds of a million dollars and was made up almost entirely of lubricating oil and grease, and paraffin wax. Similar imports into Ecuador did not quite reach \$150,000 in value compared with \$106,000 in 1923.

Comparative Position in United States Trade. On the other hand, about two-thirds of the Peruvian production of more than 6,000,000 barrels in 1923 was sold to foreign consumers. In that year 18.6 percent of the \$100,000,000 worth of all her exports were made up of crude and refined oil. The United States alone bought from Peru 1,550,000 barrels of crude oil in 1923 and 2,440,000 barrels in 1924. Peru's petroleum exports, crude and refined together, ranked third, or next to sugar and cotton in value during 1923. These shipments, while quantitatively equalling those of Venezuela in 1923, were hardly half as great as the latter in 1924. The northern oil, like that from Comodora Rivadavia in Argentina, is not worth as much per barrel because it is best adapted as fuel oil to compete with coal. While the Plate river republic must buy foreign oil until its light oil areas shall have been developed, Peru, Ecuador and Bolivia, because of the nature of their inhabitants, can not be looked upon as promising customers in the petroleum trade of the United States. South American markets for our refined products can be expected to expand mainly in Brazil and Chili. Peru should, however, retain a prominent place in our receipts of "raw" petroleum, but below both Colombia and Venezuela.

COLOMBIA, A COMING IMPORTANT PRODUCER

Districts Near Coast Disappointing. Surface signs are numerous in Colombia. Some, near the Caribbean Sea, are well located for transportation but have not signified much so far.* The potential production of the republic as a whole has not yet been determined.† The cost of delivery

* Unsuccessful so far, both in the Bolivar field near El Carmen, Standard of California has drilled below 4,000 feet and Gulf Oil Corporation to about 3,800 feet. To find oil in commercial quantities near the coast, future operations will be deep and expensive. The De Barco concession of about 2,350 sq. mi. (see map), if developed to production must await an outlet to Lake Maracaibo through Venezuela which it borders. See "Colombian Oil Fields in 1924," by L. G. Huntley, American Institute Mining Engineers.

† W. J. Archer, in *New York Commercial*, March 31, 1924. According to C. W. Washburne and K. D. White, Colombia has an almost ideal situation with respect to the world's markets, being but a short distance from the Panama Canal and the West Indies. The sailing distance from its Caribbean ports to New York (about 1,800 miles) is less than that from Tampico, Mexico, and practically the same from its Pacific seaboard. No other South American country borders on both oceans. A very complete 18-page story of petroleum in Colombia appears in a commercial and industrial handbook (Special Agents Series No. 206, Department of Commerce) by P. L. Bell, Trade Commissioner; 70 cents, Superintendent of Documents, Washington, D. C.

at tidewater will average more than in Venezuela owing to longer pipe line haul as shown below. Since 1922 the Tropical Oil Company's refinery at Barranca-Bermeja has supplied all domestic demands.

Development in the Barranca-Bermeja District. Colombia's first producer was completed in 1918 by the Tropical Oil Company on the De Mares concession 400 miles inland. This tract covers 2,061 square miles—70 miles along the Magdalena and Carare rivers and averaging 30 miles wide. Roberto De Mares obtained the concession in 1905 from the government and



—Am. Inst. Min. & Met. Engrs.

**RELIEF MAP OF COLUMBIA AND WESTERN VENEZUELA AROUND
THE LAKE MARACAIBO BASIN**

Colombia is nearer New York than any other Latin-American oil country. Note the location of Barranca-Bermeja on the Magdalena River, over half way between the seaport, Cartagena, and the capital, Bogata, in the mountains. See other map for location of the Andian pipe line and Manomai, its terminal near Cartagena.



—Mining and Metallurgy.

BARRANCA-BERMEJA REFINERY AND TANKS OF TROPICAL OIL CO.

↑ was organized in 1916 for the purpose of exploring the concession, beginning in 1917. In 1920 the International Petroleum Company, Ltd., a subsidiary of the Imperial Oil Limited acquired control in the Tropical Oil Company. Since then development has made enormous strides despite many obstacles.

Las Infantas Field Has the Principal Proven Structures. Drilling has so far been confined to the northern part of the property, 35 miles east of Barranca-Bermeja. During 1924 19 rigs were operated by the Tropical Oil Company on three neighboring structures. This "infant" enterprise was attended by a staff of doctors and nurses besides 300 foreign employes and over 3,000 natives. Road maintenance alone in this rainy region requires a large force—after finishing the expensive clearing and grading through the jungle-mantled hills. The Infantas field has wells scattered over a distance of six miles—17 completed to the end of 1924 out of 28 altogether on the De Mares concession.

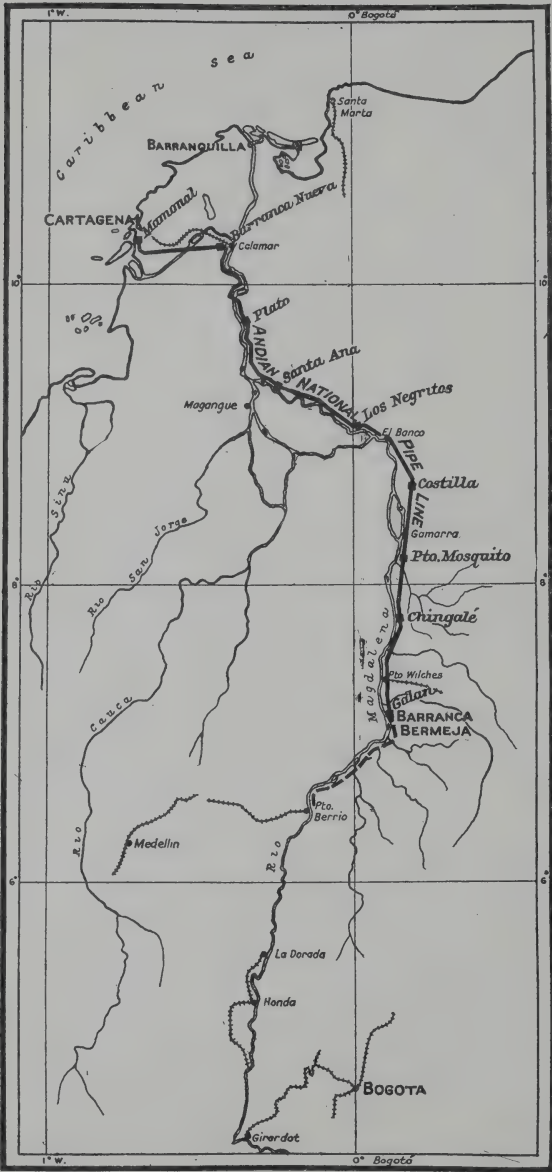
Actual and Potential Rate of Production. By early 1925 some 30 wells had been drilled to the oil sand on this concession, proving the existence of oil over a wide area. Four different oil horizons total 250 feet in thickness within a depth of 2,260 feet (comparing with the depths in Mexico). A life of 20 to 30 years is claimed for the producing wells the initial yield of which varied from 1,000 to 3,000 barrels daily. Almost all of the wells of the Tropical Oil Company are shut in while the pipe line is building. Only half a million barrels were withdrawn from the wells in 1924, or very little more than in 1923 when Colombia was credited with 425,000 barrels. The potential output of the 30 odd wells of the Tropical Oil Company alone is said to be 50,000 barrels daily, equivalent to more than 18,000,000 barrels or nearly twice as much as Venezuela produced in 1924.

American Capital in Control as in Peru. While practically all the petroleum hitherto obtained in Venezuela has come out of British and British-Dutch concessions (Royal Dutch-Shell leading by far), 100 percent of the Colombian output has come out of the American owned concession named above, and most of the other companies operating in Colombia are of American origin. Next to Tropical Oil Company (subsidiary of International, which controls five-sixths of the Peruvian production) interest centers in the operations of the Colombian Syndicate (said to be in the hands of New York bankers and the Agwi). Its properties are close to those of the Tropical Oil Company and through both of these the 360-mile pipe line of the Andian National Corporation has been laid between Baranca-Bermeja and Cartagena. (See view of first tanker load, page 172.)

Immense Mineral Wealth Awaiting Attention. A few minerals have already made Colombia famous. In gold it still leads all South American nations after mining it since Spanish colonial days. It excels the rest of the world in emeralds* with stones worth \$14,000,000 each year. Since Russia relapsed, Colombia has become the world's chief source of platinum. The output thereof in 1923 was valued at \$4,000,000. These three later enlisted the aid of Pittsburgh oil men.† The Tropical Oil Company ↑

* Like salt, emerald mining is one of the government monopolies which brings big revenue.

† These men were J. C. Trees, George W. Crawford, M. L. Benedum, and Senator John S. Weller. Imperial Oil, Ltd., which indirectly obtained control from them, is a subsidiary in turn of the Standard Oil Co. (N. J.). Much of this information has been abstracted from *The Lamp*, August, 1924.



ANDIAN NATIONAL PIPE LINE BETWEEN BARRANCA BERMEJA AND TERMINAL SOUTH OF CARTAGENA, COLOMBIA, COMPLETED IN MAY, 1926

TYPICAL SCENE ALONG SHORE OF LAKE MARACAIBO, VENEZUELA

This shows the local headquarters of the Sun-Beacon Oil Co. Another shore view shows that production is now coming from below the lake bed, a large part of which is leased to American operators.



minerals approximate \$25,000,000 in their combined annual value. Nevertheless, the country's mineral resources remain largely latent. Most notably true is this of coal, the deposits of which in Colombia constitute six-sevenths of all South America's known reserves of that fuel. In coal and railway development it is pretty much on a par with the Philippines,† where, however, the search for oil was lately abandoned after one company had spent more than \$1,000,000.

Low Density of Population Implies Undeveloped State. With an area twice that of France, but with only one-third of its territory inhabited, there extend vast stretches about which little is known. The factor most unfavorable for early and rapid economic development is the lack of transportation facilities. Unless the hydroplane route is followed, ten days must be taken to travel from the seaboard to Bogota, the capital. A unified railway system must be developed to solve this serious problem. Because of this deficiency and because of the great distances, life is centered along the Magdalena river which is navigable for 830 miles. The deepening of the old Digue canal, 85 miles long, from Calamar to Cartagena, will allow river steamers to unload at the deep-sea wharves and thus reduce the re-loading cost.

Commerce and Oil Consumption Will Grow With Greater Highways. Roadbuilding, stimulated to some extent by oil development, helped to increase the imports from the United States \$6,700,000 in one year. They were \$29,000,000 in 1924 compared with \$22,300,000 in 1923; but less than 1 percent of these imports in 1924 consisted of petroleum products.‡ In the other South American countries refined oil made up from 1 percent in the case of Bolivia to 20 percent in the case of Brazil. Exports to the United States advanced from \$46,000,000 in 1923 to \$58,000,000 in 1924. Coffee alone accounted for \$50,000,000 or six-sevenths of last year's exports to our country.

† See the author's article in *The Engineering Magazine*, February, 1906. Colombian coal beds contain nine times the 3,000 million tons credited to the coal reserves of Chili. See "The Fuel Supply of the World" by L. P. Breckenridge, *Mining and Metallurgy*, February, 1921. Read "Colombia's Riches Reviewed by Bank" (the Royal Bank of Canada) in the *New York Times*, July 3, 1925.

‡ The operation of the refinery at Barranca Bermeja to a large extent has dispensed with imports of petroleum products.



TYPICAL SCENE IN COLOMBIAN OIL FIELDS

VENEZUELA A VERITABLE TREASURE VAULT FOR PETROLEUM

Is Venezuela Replacing Mexico as a Petroleum Eldorado? American producers look to this South American republic as the greatest future source of supply.* The first commercial well was drilled in 1914 by the Caribbean Petroleum Company, then a subsidiary of the General Asphalt Company. Control soon passed to the Royal Dutch group which continued with success in the Mene Grande district. Elsewhere developments in the Maracaibo basin were disappointing until the Borroso No. 2 of the Venezuelan Oil Concession, Ltd., drilled itself in December 14, 1922, in the La Rosa field (page 11). This proved one of history's great wells, flowing wild 120,000 barrels daily for nine days. Later the same company made big discoveries west of the lake at La Paz and Concepcion in the district of Maracaibo.†

Geology and Physical Geography. Venezuela is next to Colombia the northernmost country of South America, and extends almost to the Equator. Its western part is in the same longitude as New England. It is half as large as Mexico and almost as large as Texas, Oklahoma and Kansas combined. Venezuela has a varied climate according to elevation which largely determines the three zones of mountains, plains (or llanos) and forests. The main topographic divisions are: (1) The Guiana highlands south and east of the Orinoco; (2) the great central plains extending 650 miles east and west; (3) the northeastern branch of the Great Andine chain entering from Colombia on the southwest; (4) the low Lake Maracaibo region in the northwest. Two distinct major oil districts have been differentiated: (1) The Caribbean, which includes the Maracaibo basin (four states) and the State of Falcon, and (2) the Eastern Venezuela or Orinoco basin from the delta to the Para promontory and including part of the interior state of Guarico. The formations of the former range in age from Cretaceous to recent and include limestone conglomerate, sandstone and shale up to 15,000 feet thick. Where these rise to outcrops on the edge of the Maracaibo basin they supply seepages for which this region is famous.‡

Maracaibo Basin Compared with California. Producing horizons in the Maracaibo district are analogous to the so-called "oil zones" of the Los Angeles basin and the San Joaquin valley in California. There is a remarkable similarity of physical character of the producing horizons, the geological age is approximately the same (Miocene and Eocene, see page 27), and the general structural conditions are almost identical.** These

* Julius Moritzen in *The Baltic-Scandinavian Trade Review*, November 19, 1924.

† Michael O'Shaughnessy, author of "Venezuelan Oil Handbook."

‡ "Oil Industry in Venezuela," by Senor Lucio Baldo, representative to the International Petroleum Exposition, October, 1923. J. W. Lewis in "Transactions of the Am. Inst. Min. and Met. Engrs., 1923," refers to a very small part of the 400-mile "horseshoe" of outcrops marked by oil and gas seepages. At the northern end of the Mene Grande anticline, he and Frank Wilde (in 1913) mapped 4,000 separate oil seeps and more than 600 acres of asphalt—making probably the world's most spectacular surface signs of oil.

** First noted by the California geologist, Ralph Arnold, according to E. B. Hopkins and H. J. Wasson, page 190, "Petroleum in 1924," A. I. M. E. The bulk of the proved production comes from Miocene oil sands; less from Eocene formations. The Cretaceous, though petroliferous, is highly metamorphosed in the uplands where exposed, and in the basin is too deeply buried to be the source of commercial output. The general structure is that of a horseshoe shaped geosyncline with its center occupied by Lake Maracaibo.

conclusions are evidence more and more with the progress of development. Even the rotary method of drilling, the use of which is practically established in Venezuela, is patterned after California practice.



—Photo by Arthur Knapp.

LA ROSA, LEADING VENEZUELAN FIELD IN 1926

Previously, Mene Grande had been foremost. Lago Petroleum, with leaseholds extending over the lake, is here competing with the Gulf and Dutch-Shell in drilling line wells, a common practice in the United States. (See Mining and Metallurgy, July, 1925, and page 38, Oil and Gas Journal, November 25, 1926.)

Production and exports from Venezuela in 1926 approximated 36 million barrels, making this country fourth in the world, displacing Persia.

Mene Grande and La Rosa the Foremost Fields. The Mene Grande field is on the eastern side of the lake or about 70 miles southeast of the city of Maracaibo. It yields oil intermediate in gravity to the Mexican heavy and light oils. The La Rosa field (see page 11) lies on the lake shore about 25 miles southeast of Maracaibo. Its oil is two degrees lighter than that from the Mene Grande field and about two degrees heavier than the Gulf Coast oil of Texas. In the following table is shown the importance in 1924 of these two fields compared with others in Venezuela, two of which, La Paz and Concepcion, both producers in 1925, are located on the west side of Lake Maracaibo.

Field	New Wells	Production in 1924, barrels	Wells producing	Gravity, degrees	Age, years
Mene Grande	16	5,240,000	37	18	9
La Rosa	13	2,960,000	20	20	3
El Mene	11	1,050,000	25	37	2
La Paz	2	None shipped	3	28	1
Concepcion .....	..	None shipped	..	37	1

Tremendous Potentiality; Production Tied Down. Assuming that only 75 wells were producing throughout 1924, the average per well would make 123,000 barrels, equivalent to almost 340 barrels per day or 50 times the average in the United States. One authority rates Santa Rosa alone with a daily capacity of 200,000 to 400,000 barrels, or the same as 73 to 146 million barrels per annum, if the wells were all opened wide. This does not seem to be a great exaggeration in view of the fact that several wells have been credited with 50,000 to 75,000 barrels initial yield under high

New wells completed in 1924; none were dry except six in El Mene where the total completed was therefore 17 producing wells as of January 1, 1925.

gas pressure and that no dry wells have yet been drilled. Many wells elsewhere around Lake Maracaibo were either pinched down or entirely shut in pending improvements in transportation. It is not hard to believe that Venezuela will produce between 45,000,000 and 50,000,000 barrels in 1927. Future output will be limited largely by conditions in the world markets and by the availability of transportation facilities.*

British Capital Dominates Production. After nearly nine years of oil productivity in Venezuela, American capital has barely begun to share therein, as shown in the following list of potentially producing concerns as of late 1924 (name of oil field and daily capacity in barrels within parentheses): Royal Dutch-Shell, through management of Venezuela Oil Concessions, Ltd. (La Rosa, 30,000), (La Paz, 20,000) and (Conception 10,000); Royal Dutch-Shell through ownership of Caribbean Petroleum Company, (Mene Grande, 15,000) and of Colon Development Company (De Oro, 2,000) and (Tara, 2,000), making owned and controlled altogether 79,000 barrels or 53.5 percent of the total; Lago Petroleum (Sir James T. Currie, Pres.) (La Rosa, 30,000 from wells, 1,500 to 1,900 feet deep); Creole Syndicate†



EL BANO WELL OF THE SUN-BEACON OIL COMPANY

This Philadelphia concern owns concessions on 1,500,000 acres in the district around Lake Maracaibo. It is a subsidiary of the Sun Oil Company.

Among other large companies interested in Venezuela may be mentioned the Atlantic Refining, Anglo-Persian, British Controlled Oilfields, British Equatorial Oil, New England Oil Corp., Pure Oil Co. (owning Orinoco Oil), Sinclair Consolidated, Standard of California (owning Richmond Oil), Standard of New Jersey (through Standard Oil Co. of Venezuela), The Texas Co., and Union Oil Co. of California.

Gulf Oil Corp. jointly with Lago Petroleum is developing the new and deep Lagunillas field in Venezuela, these two having three-fourths of the 27,000 bbls. daily yield early in 1927. Although the discovery well was not completed before August, 1926, Lagunillas has already moved ahead of Mene Grande and ranks next to La Rosa in daily production.

* According to the Mexican-Venezuelan Service Bureau, quoted in *The Oil and Gas Journal*, January 22, 1925, the deepening of the Lake Maracaibo outlet for ocean-going tankers has been abandoned; likewise the pipe-line plan of the Dutch-Shell interests. Engineering, economic and political difficulties prevent the dredging of the bar now 11 feet deep. As was the situation in the Panuco field of Mexico for some time, so for the present Venezuelan oil must continue to be removed from the Maracaibo basin by shallow-draft tankers to deep harbor (s) for trans-shipment. See reference to Curacao on a preceding page. (The second "c" in Curacao is sounded like "s.")

† Of 25 West 43rd St., New York; C. K. McCornick, president; H. G. Cortis, vice-president, and Robert Trumpley, secretary-treasurer. For further details see article by Michael O'Shaughnessy in *The Oil and Gas Journal*, December 18, 1924, recent proceedings of the Am. Inst. Min. and Met. Engrs., U. S. Commerce Reports of June 30, 1924, and recent issues of *The Wall Street Journal*, March 2, 1925, etc. *Oil News* of London for December 27,

jointly with Venezuela Gulf Oil Corporation, both American (La Rosa, 30,000).

Venezuela Advanced in 1925. A gain of about 11,000,000 barrels, or almost 120 percent, over the output of 9 million in 1924 placed this republic 3 million ahead of Rumania, which hitherto had ranked sixth in world production. The actual exchange in rank occurred early in 1925. Two new shipping fields began operations—La Paz and Conception—making a total of five, all located in the Maracaibo Basin. Exports were made through the port of Maracaibo by the three principal companies: Dutch Shell, Largo Petroleum, and Venezuelan Gulf Oil. They amounted to 19 million barrels. The difference between output and export represented oil refined locally, sold as fuel and consumed in drilling operations.*

The La Rosa field was more active in 1925 than all the others, due to competitive drilling of the V. O. C., Ltd., Lago Petroleum, and Venezuelan Gulf Oil Co. whose wells range from 1,450 to 2,800 feet in depth. Mene Grande, monopolized by the Caribbean Petroleum Co., was extended to 3,300 acres total proved. The outstanding feature of El Mene development by the British Controlled Oil Fields was the bringing in of a 980-foot well for 2,100 barrels early in 1925, followed by others of high initial, with rapid decline to settled yield. In El Mene were drilled seven dry holes, the only ones in Venezuela, making the average hazard rate in 1925 only 4.4 percent for all the fields, or zero percent outside of El Mene. With the laying of pipe lines La Paz—Conception—Punta Piedras, water shipments began in July and totaled 550,000 barrels by the end of 1925. *New discoveries* include the Ambrosia pool, apparently an outlier of La Rosa field, and the Guanoco, a heavy-oil field near Guanoco asphalt lake in eastern Venezuela. The former was found 6½ miles north of La Rosa, under Lake Maracaibo, and hardly half a mile from shore, at a depth of 1,378 feet.

Output in 1924 and 1925. The following figures are based on tables compiled by the American Petroleum Institute and E. L. DeGolyer:

World rank	Latin-Am. country	(Million bbls.) 1924	(Million bbls.) 1925	Per- cent	World rank	Latin-Am. country	(Million bbls.) 1924	(Million bbls.) 1925	Per- cent
2	Mexico	140	115	10.8	16	Colombia	0.4	1.0	.1
6	Venezuela	9.0	20	1.9		Cuba, etc.....	.01	.01	..
8	Peru	7.8	9.1	.9					
11	Argentina	4.7	6.5	.6					
13	Trinidad	4.1	5.0	0.5					
						Total Lat.-Am..	165	156.6	14.8

During the three years 1923-1925, production was practically stationary, South American gains being offset by Mexican losses. There will be noticeable increase south of Panama after the completion of the Columbian pipe line (May 1, of 1926) and the deepening of the outlet from Lake Maracaibo. Two countries improved their rank in 1925: Venezuela displaced Rumania, and Peru passed India. Never theless, because of Mexico's loss, Latin America's percentage of the world total dropped from 16.3 in 1924 to 14.8 in 1925. The world increase of about 50 million from about 1,015 million barrels in 1924 was almost equaled by that of the United States and was about 10 million more than the output of all South America in 1925.

* Standard of N. J. has arranged for rights to the B.C.O. output above the 20,000-barrel limit controlled by the Shell interests. The daily production of the B.C.O., Ltd., was around 6,000 barrels early in 1926, according to *The Wall St. Journal*, Feb. 8, 1926. Most of the data above was abstracted from an A. I. M. E. paper by E. B. Hopkins, consulting geologist, and H. J. Wasson, geologist for the New England Oil Co.

MEXICO, LAND OF SILVER, SISAL HEMP AND HEAVY OIL

Wealth Is Vast and Varied; Unevenly Distributed and Developed. Despite its large areas of arid, semi-arid and mountainous land—hardly 40,000 square miles, or 5 per cent of the total, being tillable—Mexico is immensely wealthy due to her vast deposits of minerals, and in less measure to her range in climate. Because of the latter and the topography this republic is rather independent of foreign importations of food, fibers and forest products. Since half of the country lies within the tropics, her agricultural products are extremely varied. Except for certain manufactures, Mexico is surprisingly self-sustaining. Her people, mostly of mixed and pure Indian blood, are devoted mainly to farming south of the 24th parallel and to grazing and mining north thereof. After agriculture, mining is Mexico's oldest and most important industry; but the revolution raised havoc with it as it also hindered the development of the oil industry, though less permanently.* A premature revival in mining began in 1920, but no marked improvement was noticed before 1923.†

Significance in Our Latin American Trade. With few exceptions, Mexican farm and range products are raised for home consumption; mineral products for export mainly.‡ While Chili supplies most of the nitrate needed by American farmers and others, it is Mexico that cultivates the maguey plant in Yucatan from which we get sisal hemp or hennequen of commerce for making binding twine. Ten years ago, the United States bought more than twice as much of such hemp as of mineral oil from Mexico; and excluding gold and silver, this fibre then made up one-fourth of all our Mexican imports in point of value. While our imports of hennequen, hides and coffee were falling off after 1912, our takings of petroleum have tremendously increased. From 12 per cent of \$93,000,000 worth of all our Mexican imports in 1913-14, mineral oil advanced to nearly 55 per cent of \$167,000,000 in the calendar year 1924. The \$91,000,000 worth of oil was then equivalent to half the value of our receipts of coffee from all Latin America in 1923. While we buy a little more from Brazil and twice as much from Cuba, on the other hand Mexico, at least in 1924, was more than twice as big a customer as Brazil. Strange to say, Mexico is our third best Latin American customer for petroleum products. For obvious reasons, our purchases of Mexican petroleum has helped to maintain our profitable export trade in refined mineral oil.

* Despite the exigencies of war, which marked the Spring of 1915 in Mexico's petroleum belt, property damage sustained was relatively small. Greatest sufferer was the Mexican Petroleum Co., at Ebano, where Villistas fought Constitutionalist forces. The company lost several steel tanks including one of 55,000 barrels capacity while three similar ones were badly damaged. Oil losses aggregated 150,000 barrels. Buildings were more or less ruined by shell fire. Eventually the Villistas were driven back. But in May they occupied the Panuco fields, stopping river shipments. Due to ample storage at Tampico, actual exports were not affected. Pipe-line transportation from the southern fields to either Tampico or Tuxpam was not interrupted.—Geo. Blardone in *The Oil and Gas Journal*, January 13, 1916, reprinted in "U. S. Mineral Resources," 1915, Part II, page 730.

† Compared with the high record of production in 1912, the year 1923 showed 11.7 per cent increase in silver, 48 per cent in lead, and 1,360 per cent in zinc. Copper and gold decreased 6.7 and 25.4 per cent respectively. The Mexican Embassy, according to the *Wall Street Journal* of July 23, 1925, reported the output in 1923 to be 342,600,000 pounds; lead, 117,400,000 pounds; copper, 6,200,000 pounds; silver, 638,000 ounces, troy of gold, and minor amounts of mercury, zinc ore, graphite, manganese and arsenic. Mexico keeps it place as the world's leading source of silver, the second in lead, the fifth in gold and the seventh in copper.

‡ Iron and coal are the only important mineral products not produced for exportation, for they do not suffice for the domestic demand.

MEXICAN PETROLEUM PRODUCTION

The Mexican Oil Fields: Location and Area. There are two oil regions: (1) The Isthmian or Minatitlan and (2) the Tampico-Tuxpam. They are 300 miles apart although largely within the State of Vera Cruz. The former is located on the Isthmus of Tehuantepec and yields the lightest oil in Mexico, but on a scale rather scanty. The important producing fields occur in the northern part of Vera Cruz and across the Panuco river in Tamaulipas, 300 miles below the Rio Grande.* The oil territory, embracing much barren ground, extends over 25,000 square miles. Considered semi-proven is 10,000 square miles of which one fifth is owned by one American company alone. Productive to date are fewer than 25 local fields or pools aggregating less than 100 square miles.

Noteworthy Physical Features of the Tampico-Tuxpam territory, which lies within the Gulf Coast plain,* include (1) the absence of natural harbors other than the mouths or lower channels of the larger streams, the bars at the entrance of which must be dredged; (2) the belt of lagoons, too shallow for ships but navigable for flat boats, notably the long Tamiahua; (3) the wide and flat valley of the Panuco wherein bedrock is obscured by a blanket of recent deposits, and (4) the low, conical hills which mark the surface signs of volcanic plugs. As a fitting background for the oil fields and coming closer to the coast the farther south, the oil bearing Tamasopo limestone turns up on edge 60 to 70 miles west of Tampico and there helps to form the Sierra Madre along the border of the highlands.

Structural and Economic Geology. The general structure of this region—the source of 99 per cent of the Mexican oil—is that of a monocline of Cretaceous, Tertiary and Quaternary strata dipping easterly under the Gulf. The principal oil-bearing beds are limestones and limy shales of Cretaceous—Eocene age. The parent rock appears to be the Tamasopa limestone which still retains much of the oil in its uppermost and cavernous horizon. It thickens from 3,000 feet in the latitude of Tampico to fully 10,000 feet towards the south. It deepens also in the same direction, being beyond reach of the wells drilled south of the Tuxpam. Along volcanic necks and dikes of basalt much of the oil has migrated upward into the San Felipe shale and limestone, and into the overlying Mendez marls and clays.†

Quality of the Crude Oil. Except for the minor and much lighter oil obtained from Furbero and the Isthmian fields, Mexican petroleum presents two grades: (1) The so-called light crude (considered heavy in the United States) is found in the southern fields, that is, in the string of pools extending south from Dos Bocas to Alamo, and (2) the heavy crude coming

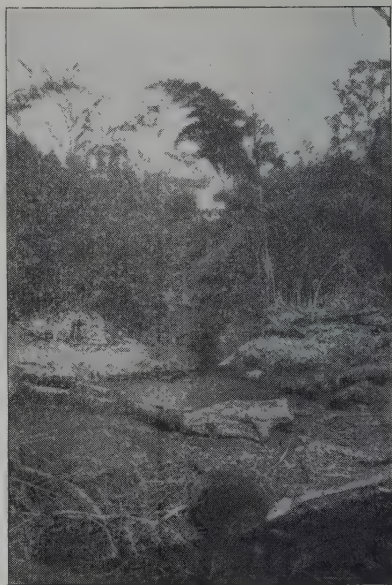
* This plain is locally known as "La Huasteca" or (climatically) as "Tierra Caliente." From three to ten miles inland it is low, sandy and destitute of vegetation. Back of this narrow belt the surface, covered with a dense growth of tropical plants, rises gradually to the foot of the steep ascent of the Sierra Madre. The Gulf Coast plain is about 60 miles wide south of parallel 22° North and widens farther north to 150 miles. Partly abstracted from "Plain Facts About Mexico" by G. J. Hagar, Harper & Bros.

† The domes of the light-oil area appear localized along a crescentic anticline (or major fault ridge?), the "Golden Lane" of Mexico's past production. The Tamasopa limestone represents organic deposits formed on a sinking sea-bottom when the Gulf of Mexico was connected with the Gulf of California via the submerged Isthmus of Tehuantepec. This enormously thick limestone is considered the equivalent in age to the Woodbine sand of east-central Texas (Powell), southern Arkansas (Snackover) and northern Louisiana (Caddo and Haynesville). See part V in the revised "Manual for the Oil and Gas Industry," Bureau of Internal Revenue, 1921; also "Mexican Petroleum" by W. J. Archer, 1922.

FLOATING OIL ON TROUBLED WATERS

A beautiful scene in the Southern or Light Oil field a little north of the Tuxpam River, showing bamboo growth in the background and seepage oil on the surface of a small stream.

The pacifying effect of petroleum on stormy waters is well known. Unfortunately, in international relations oil apparently adds fuel to the flames of diplomatic disagreement. As a reward for contributing heavily to the financial support of the Mexican Government, the confiscation of their oil properties acquired before 1917 is bitterly opposed by American and British producers of Mexican petroleum.



from the Panuco valley fields which include the various sectors of Panuco proper as well as the Ebano, Chijol and Topila fields or districts. The light crude runs from 19° to 22° Baumé and yields 10 to 13 per cent gasoline by topping. The heavy oil has a gravity ranging from 10° to 15° and is chiefly used as fuel oil, with or without topping. Most of the Mexican oil is of asphalt base, but a small per cent of paraffine wax has been obtained from the light or southern oil. Some of the latter has been completely refined, giving 35 per cent lubricating distillates.*

Torrid Temperature a Peculiarity of Mexican Petroleum. The crude oil is characteristically warm to very hot. The temperature varies from 90° to 181° Fahrenheit (32° to 83° Centigrade) as the oil leaves the ground. Its average temperature in the Ebano field is 105° F., and at the Dos Bocas well the salt water and oil was as hot as 165° F. This natural liquid for some reason becomes generally warmer the farther south the wells are located between Ebano and Alamo. The temperature of the oil is of great value from an economic viewpoint in that it decreases the viscosity of the fluid and permits it to move more freely through the pipe lines. At times, therefore, the temperature has been a factor in determining the rate or daily production. As it is, most of the heavier or sticky crude must be heated.†

*According to Col. George A. Burrell, in *National Petroleum News*, February 4, 1920, a considerable portion of the light oil is completely refinable: Gasoline, up to 15 per cent; kerosene, 7 per cent; light lubricating distillate of 26° gravity, 25 per cent; heavy lube distillate of 20° B., 10 per cent; gas oil and coke, 15 per cent, and 1.3 per cent by weight, of refined wax. Some of the heavy oil contains fully 65 per cent asphalt. Lighter oils, richer in gasoline, are found farther south, as at Furbero (gravity 24° B.) and in the Tehuantepec or Isthmian field (36°). In October, 1924, it was reported that oil as light as 50° B. had been found in the Huasteca Company's No. 8 Tres Hermanos at a depth of 3,735 feet and with an initial yield of over 2,000 barrels.

†The light oils have the higher temperatures. See U. S. Commerce Reports of October 24, 1921; also the author's chapter on the Mexican Oil Fields in the revised "Manual for the Oil and Gas Industry," U. S. Treasury Dept., 1921.

ONE OF THE MANY VOLCANIC NECKS

These plugs have penetrated the oil-bearing shales and limestones with sills extending horizontally here and there. In cooling and contracting, voids were left for the oil to fill very close to the basalt. This view, taken near Ebano, shows oil tanks of the Mexican Petroleum Company.



—From photo by the author.

A QUARTER CENTURY OF MEXICAN TREASURES AND TRAGEDIES

American Entrepreneurs Establish the Industry.* In May, 1900, C. A. Canfield and E. L. Doheny, at the suggestion of the president of the Mexican Central Railway, examined the prospects tributary to that line and located west and southwest of Tampico. So well impressed were they with the remarkable seepages that they acquired 450,000 acres in fee before completing the first well. This event occurred on May 14, 1901, oil being struck at the shallow depth of 545 feet. It marked the beginning of the Mexican Petroleum Company's operations in the Ebano field along the railway, 35 miles west of Tampico. In April, 1904, the first gusher in Mexico was brought in by this company. It flowed 1,500 barrels daily,† a modest affair compared with the smashing records which followed in the southern fields. Unfortunately, no substantial markets for this oil of fuel grade was secured until in May, 1905, when the Mexican Central Railway Company contracted for 6,000 barrels daily. Considerable asphalt had been made, however, for paving use in Mexico City. As a result of Mr. Doheny's personal investigations south of the Panuco River, lands in the Southern oil district were acquired in 1905 and 1906.

*** History of Pre American Petroleum Development.** The earliest reference to oil as an industry was the recording, in 1857, of an agreement whereby a group of merchants in Tabasco were to exchange cacao for iron sheets needed in making oil tanks. The natural product, known as "illuminating oil," came from a spring near Macuspana within the Isthmian fields. In 1865 the Government authorized a Spaniard to exploit deposits near San Jose de las Rusias, Tamaulipas. The favorable results led to the organization of a company in 1868 by Mexican planters for exploiting petroleum seepages and springs located near Furbero, Vera Cruz. This attempt and another made in 1878, also near Furbero, proved failures. In 1876 a Boston sea captain brought back with him from Tuxpam some "chapopote" or tar. This caused the forming of a company to drill for oil on leased land known as Chapopote Nunez and Cierro Viejo, just north of the Tuxpam River and 35 miles north of Furbero. A little oil was obtained in two wells about 500 feet deep, only two miles from the Potrero del Llano field of subsequent fame. Lacking financial support for expansion, the old captain became discouraged and committed suicide in the early eighties.

Later on Cecil Rhodes' attention was attracted to the oil possibilities south of the Tuxpam. His syndicate, the London Oil Trust, spent \$400,000 in a futile fashion, and its successor similarly spent fully \$300,000. This affair was finally and unfairly abandoned because of the unfavorable report made by a young geologist sent to Mexico by Sir Boverton Redwood. Had these early explorations been extended north of the river and persisted in a little longer, there is no telling but what British instead of American capital would have benefited the most from the development of Mexican mineral oil. Early in this century, even the Geological Institute of Mexico had grown pessimistic with regard to the creation of a petroleum industry in that country based upon its domestic resources. —U. S. Commerce Reports, September 13, 1920, and "Mexican Petroleum" by W. J. Archer, 1922. For detailed history of Mexican petroleum from the days of the Aztecs to the middle of 1922, read the article in *The Lamp* of August, 1922, contributed by R. Leibensperger, chief geologist for the Transcontinental.

† Sixteen years later, this well was flowing 800 barrels daily, a loss of less than 50 per cent, an evidence of the wonderful vitality of Mexican wells.



—From photo by the author.

PATRIOT, PIONEER AND PROPHET "Man of Vigor and Vision"

Edward L. Doheny, Sr., in a prophetic attitude at one of the huge seepages in the Light Oil district to the south of Tampico (see Chapter XII).

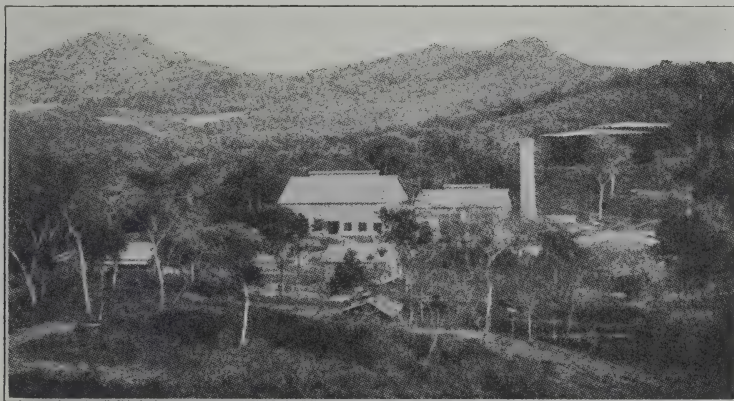
The oil exudes here from joint cracks in the lava rock near the contact between a volcanic "neck" or "plug" and the surrounding sedimentaries. This view was taken by the author in 1921 within Morallillo near the Buena Vista River and the historic ruins of Piedra Labrada situated about five miles west of Cerro Azul, the world's greatest oil well. (This Doheny discovery of February, 1916, is still producing—near the "blue peak" of the same name.)

British Capital Contributes to Quick Development. In 1904 an affiliation of "El Aguila" (or Mexican Eagle, then a Pearson interest)* opened the much lighter oil deposits (of 26° Baume gravity) at Furbero, 125 miles south of the Ebano field (the oil from which is extremely heavy, viscous and asphaltic). The output in 1917 was hardly 35,000 barrels compared with more than 1,100,000 from Ebano. In 1908 the Pennsylvania Oil Company (taken over by the Mexican Eagle) brought in a 2,500-barrel well (San Diego No. 2 at 2,006 feet) in the Dos Bocas pool (see map). Four months later, on July 4, 1908, the famous Dos Bocas gusher (S. D. No. 3 came in at 1,825 feet) but caught fire almost at once. The flow was estimated at 150,000 to 200,000 barrels a day, so that some 10,000,000 barrels of oil burned by the end of August, when salt water replaced the oil.† Thus was ruined an entire pool. Over \$3,000,000 worth of oil and equipment was destroyed in this disaster; but Lord Cowdray (then Sir Pearson) did not lose courage. The efforts of Mexican Eagle were finally crowned with success despite a financial struggle with the Waters-Pierce Oil Co.. As narrated below, sixteen months after the Dos Bocas disaster, Lord Cowdray's company came into its own with the drilling of a monster well.

* In 1902 the same interest had begun operations in the Isthmian zone, later building a large refinery at Minatitlan; but production was never important, dropping from 226,000 barrels in 1915 to less than 1,000 in 1919. The occurrence of petroleum in the Tehuantepec field is connected with salt domes and is thus similar to the Gulf Coast fields of Texas; but the oil-bearing formation, a Cretaceous dolomitic limestone, is older than some of the oil sands of the latter, according to A. H. Refield in *Engineering and Mining Journal*, March 19, 1921 (see pages 27 and 36).

† When the author passed by it in 1921 sulphurous salt water was still gushing out of its huge crater, at a rate of over 1,000,000 barrels daily according to one informant.

A Memorable Period in the History of Mexican Petroleum. The year 1910 ushered in a new era in the evolution of the Latin American oil industry. In February was found the Potrero del Llano pool through the drilling of a 500-barrel well to the depth of 1,933 feet. But not before the day after Christmas did Potrero No. 4, from a depth of 1,911 feet, belch forth one-fifth of a million barrels per day. Offsetting these achievements of the Mexican Eagle, the Doheny company drilled in Juan Casiano No. 7 on September 11, originally making about 70,000 barrels a day. Thus was established the commercial value of Mexico's light-oil area through the discovery of two great pools 25 to 30 miles apart. This crescentic "Golden Lane," has gone down into oil history replete with tremendous treasures and tragedies. The greatest sensation was reserved for early 1916, an event foreshadowed by the eminent oil geologist, Israel C. White (page 65).



—Los Angeles Oil Bulletin.

PART OF THE SMALL CASIANO BASIN, VERA CRUZ, MEXICO

One of the pumping stations of the Huasteca Petroleum Co., a subsidiary of the Mexican Petroleum Co. (Pan-Am. Pet. and Transp. Co.); daily capacity 60,000 bbls.

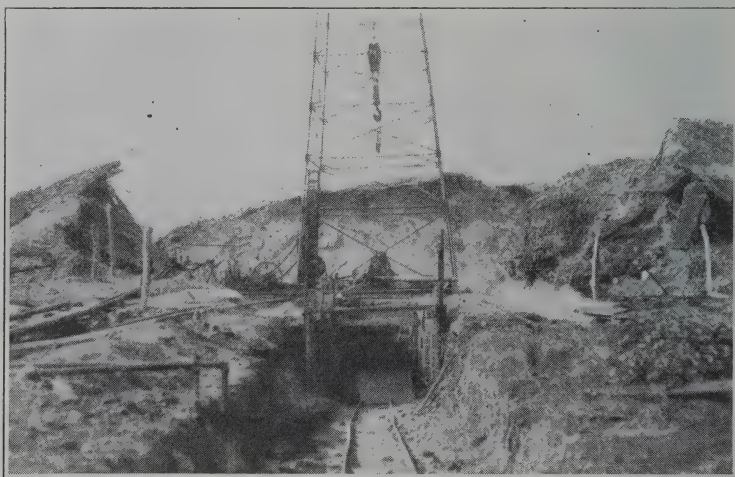
Finding The Major Field of Heavy Oil. In the same year, 1910, only a decade after the arrival of Messrs. Canfield and Doheny, the major field of the Northern district, 15 miles southeast of Ebano, was discovered by the East Coast Oil Co., (a Southern Pacific subsidiary). The first Panuco producer, one mile southwest of the village of that name, was then brought in at 1,781 feet, but good only for 10 barrels daily. This was a small beginning for the Panuco field whose various sectors are now producing twice as much as all the southern fields.* It has never been as spectacular as the Southern district, its big wells rarely running beyond 10,000 barrels daily. In 1914, however, the Corona (Royal Dutch Shell), at 1,806 feet, brought in a 37,000-barrel well located but two miles from the discovery well.†

Three Famous Fountains of Oil. The world's most celebrated and commercially successful wells are the Cerro Azul No. 4, the Potrero del Llano

* The heavy-oil or northern district, to which Panuco belongs surpassed the southern district in production during the week ended March 24, 1923, the former then averaging 205,000 barrels daily. For thirteen years the light-oil district had held the leadership.

† As in the United States, the initial yield of big wells has often been exaggerated. From 100,000 to 150,000 barrels daily was variously claimed for Corona No. 5. From 1917 to 1925, chiefly in 1921, a number of southern wells came in at 30,000 to 100,000 barrels—from three to ten times as great as the gushers of the Panuco, Ebano and Topila fields.

and the Juan Casiano No. 7. The last, while not the discovery well of the Casiano-Tepetate field, was easily shut in, permitted to flow 20,000 to 25,000 barrels daily and by November, 1919, had alone drained the larger twin pool of its 85,000,000 barrels of petroleum. Not nearly so sensational as the other two, it may never be surpassed by a single producer outside of Mexico. Similarly, the Potrero pool was exhausted almost entirely by one well. Potrero del Llano, ran wild for 8 weeks, its pressure being 270 pounds greater per square inch. More than 10,000,000 barrels of oil escaped to the sea down the Buena Vista and Tuxpam Rivers* The greatest gusher of all is said to be the Cerro Azul No. 4. Most spectacular was its spouting of oil to a measured height of 600 feet. The gas pressure was terrific, destroying the derrick and throwing the 2-ton drill bit and stem out of the well and 125 feet away. The gigantic force was finally chained in one-sixth the time it took to capture its nearest rival, Potrero del Llano.



—Courtesy of W. J. Archer

POTRERO DEL LLANO NO. 4 IN 1926

This famous well went to salt water Christmas, 1919, but in the spring of 1926 was yielding 1,000 barrels of oil daily.

Year drilled	Name of well	Life, years	Rock pressure	Depth, feet	Yield, thousand bbls.	
					Initial daily	Ultimate
1910	Juan Casiano No. 7.....	9	580 lbs.	2,112	70	85,000
1910	Potrero del Llano No. 4.....	8	850 lbs.	1,911	200	98,800
1916	†Cerro Azul No. 4.....	.	1,035 lbs.	1,752	261	Active

* During the revolutionary days, ten years ago, the Mexican Eagle Oil Co. enclosed their great well in a solid cement black for protection against the frolics of the warring factions.—*The Oil and Gas Journal*, March 5, 1914.

† In February, 1921, the author saw the drill stem at the spot where 16 feet of it was driven into the ground within ten feet of the moving-picture operator. The well itself is obscured by a mound of earth piled up to prevent fire. Cerro Azul has been flowing almost 11 years, or since February 10, 1916. Potrero del Llano came in December 26, 1910, and Casiano No. 7, September 11, 1910. The average daily yield of the last named was over 21,000 barrels, but little less than the combined daily output of Pennsylvania's 75,000 wells in April, 1925. Cerro Azul No. 4, to May 1, 1925, had produced 76,177,637 barrels of (Mexican) light oil. In August, 1925, it was averaging 6,000 barrels daily, equivalent to a yearly rate of 2,000,000 barrels. *The Wall Street Journal*, August 1, 1925, was wrongly informed in a dispatch from Mexico that Cerro Azul No. 4 has become the world's second largest producer. Casiano No. 7 will likely retain that honor fully four years longer. Both now belong to Pan American (Eastern) which is controlled by Standard of Indiana.

Marvelous Manifestation of Southern Wells. From 1910 to 1921 there were discovered 8 or 9 light oil pools which before 1925 had each produced from about 11,000,000 barrels (Zacamixtle) to 250,000,000 barrels (Lower Chinampa). Of the great gushers born along the crescent—Dos Bocas to Tierra Blanca—four have already been referred to. They were the greatest the world had ever known. Many of the others exceeded 50,000 and even 75,000 barrels daily initial, comparing with the Lucas gusher and the Lakeview, the two greatest in the history of the United States. In the course of 15 years, through fewer than 400 perforations about 825,000,000 barrels of Mexican light oil was extracted. To flow an equal volume of water, the Potomac at Great Falls would need nine days. Impressive indeed is the outbreak and the capture of the wild wells. Oil men outside of Mexico are mystified by the unfailing uniformity in the daily production of each well not offset. Outsiders are no less startled by the statement that pumping wells are “rare birds” in the Tampico-Tuxpam region.* With so few wells drilled in the southern district, the average daily yield per well has been very high—at one time over 2,000 barrels compared with only 6 or 7 barrels in the United States.

The Explanation of the Extraordinary Behavior. In both the heavy and light oil fields of Mexico the propellant is not gas but hydrostatic pressure, that is, the force of imprisoned sea water, “fossil salt water” as it may be called. It is not connected with the open ocean, neither is it like the artesian water which feeds into porous beds from a higher elevation and owes its pressure to such a head. Eventually salt water appears in all Mexican wells, and in some cases very suddenly replaces the oil. Such was the fate of Juan Casiano No. 7 which for 110 months maintained a daily flow of about 22,000 barrels.† Moreover, Mexican petroleum, as found in the Tampico-Tuxpam fields, appears to move underground in an unrestricted manner. Connected and more or less open passages are likely present in the cavernous limestone or along its contact with the shale. The cooling and consequent contraction of the igneous intrusions, also left channels along the contact with the sedimentary beds for the free flow of the liquid fuel.

Comparison of Mexican with American Fields. The oil fields of the United States differ greatly from those of Mexico, geologically as well as commercially. The age of the former varies greatly (page 26) while that of the other is almost entirely late Cretaceous and early Tertiary. Owing to this fact our oils have a much greater range in quality—from the heavy

* It is safe to say that fewer than 4 per cent of the wells in the United States are flowing at any one time. Probably less than ten out of Pennsylvania's 75,000 are producing under natural pressure. The first well in Panuco to be placed permanently on the pump was the Penn-Mex Fuel Company's No. 1 Tessada, according to the *Fuel Oil Journal*, November, 1913. This contradicts the broad statement on page 320 of Pogue's excellent “Economics of Petroleum” to the effect that no pump has ever profaned the casing of any Mexican well. “These wells are born in the full virility of their gigantic powers. They live like giants, straining at the chains that bind them, and they die as giants should, stricken as by a thunderbolt.”

† Since so few of the world's oil wells are located in synclines (pages 23 and 24) replacement of oil with salt water becomes their inevitable fate. In Mexico and the Gulf Coast fields of Texas a rise in temperature of the oil gives warning of the coming tragedy. Most of the light-oil pools of the Tampico-Tuxpam region have gone to salt water largely or entirely during the past six or seven years. According to Edward DeGolyer, a well on lot 190, Amatlan, closed as non-productive September, 1921, was reopened in 1922 and early in 1923 was yielding 1,700 to 2,000 barrels daily. A well in Alazan pool (just north of Potrero del Llano) produced intermittently during four years after the first appearance of salt water, a total of 2,000,000 barrels, and early in 1923 was flowing about 2,000 barrels daily. More than half the oil obtained in the United States is from wells which have shown or now make salt water, and wells are still being drilled in the older and partly abandoned Mexican pools for “strippers.”



—The Texaco Star.

SCENES FROM MEXICO'S MAJOR OIL FIELD—PANUCO

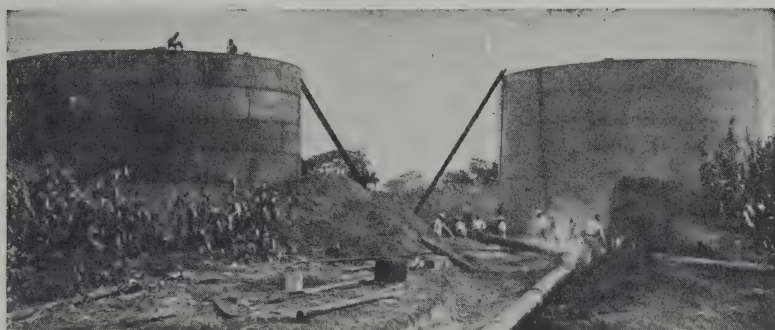
A well of The Texas Company of Mexico, closing in the gusher, and the quintette which "captured" the wild well; also (lower three views) the heavy oil, of about 14 degrees Baumé, discharging into earthen reservoir. Note coating of ice on flow line to pit caused by expansion of gas accompanying the oil. Paz No. 1 came in late in 1922 at 2,084 feet; initial production, 40,000 bbls. daily, cut to 7,000 when pinched on account of salt water. The 4,000,000 bbls. of Mexican crude produced by the Texas Co. in 1922 made 2.2 per cent of the total for all producers.

fuel oils of California to the light Pennsylvania grade which is rich in gasoline, kerosene and lubricants. Our fields are more scattered; the active Mexican fields are almost confined to two parts of one State. Ours have been producing 65 years—three times as long as the Mexican fields. It was necessary to drill 660,000 wells (not all successful) to produce 8,300 million barrels of American oil by the middle of 1925; but only 3,000 wells have been drilled in Mexico to deliver 1,300 million barrels. Some 300,000 live wells in the United States were July 1, 1925, averaging 6.5 barrels daily from a weighted average depth of about 3,000 feet while no more than 1,000 producing wells in the other republic averaged about 300 barrels each from an average depth of no more than 2,000 feet.* Both dry-

* According to Blardone there were 870 producing wells in Mexico, June 30, 1924. These had an average daily yield of 439 barrels per well or a total of 382,000 barrels, a little more than the average daily of Texas throughout the year 1924.

well hazards and drilling costs are from 2 to 5 times as great as in the United States. Comparisons below are made with oil fields in three States where conditions do not entirely differ from those prevailing in Mexico.†

Point of comparison	Gulf Coast	Mexico	California	Arkansas
Producing area, miles.....	25-30	90-100	185	50-60 ?
Usual geological structure...	Salt dome	Faults, folds	Anticlines	Low domes ?
Age, chief oil horizon.....	Ter., Quat.	Cret., Ter.	Tertiary	Cretaceous
Range of depth, feet.....	100-4,500	1,400-2,700	400-6,737	1,100-2,800
Average depth, 1925.....	3,100 ?	1,900-2,100	3,200 ?	2,300 ?
Quality of oil—base.....	Asp. & Par.	Asphalt	Asph. (paraf.)	Asphalt
Quality—gravity range, B....	15°-32°	10°-22°	11°-41°	18°-31°
Heavy oil, 1925 (10°-25°)...	100%	100%	58%	85%
Gasoline yield	Low	Low	Variable	Low
Temperature of oil F.....	Up to 110°	90°-181°	Gas pressure	Ordinary
Natural propellant	Gas pressure	Hydrostatic p.	2,250 mil	Gas pressure
Output to end of 1925, bbls...	530 mil.	1,360 mil.	670,000	175 mil.
Average daily, Aug., 1925...	100,000	260,000	Long B. mid'y	240,000
Price at well, Aug., 1925...	\$1.25-1.50	\$1.00-1.20	\$1.25-2.40	\$.85-1.35
Principal markets	Dom. and For.	Foreign	S.W. U.S., For.	Domestic, U.S.



—The Texaco Star.

FIELD STORAGE FOR THE HEAVY MEXICAN CRUDE OIL

To reduce its viscosity this oil is usually heated before pumped through pipe lines. Mexican concrete reservoirs can hold about 25 million bbls.; steel tanks, about 59 million bbls.

PRODUCTION AND TRADE IN MEXICAN PETROLEUM

Six-sevenths of World's Oil from North America Republics. Considered together, the United States and Mexico occupy a unique position in the world's mineral industry. They contribute about 60 per cent of the copper, lead and silver, and almost the same per cent of the zinc. In the last named metal the southern republic has made huge gains in the past two years. Mexico is now first in silver and second in lead but only seventh in copper. It became a commercial producer of petroleum in 1901, the same year that Russia attained her peak with 51 per cent of the world's 167 million barrels. Mexico's rise in mineral oil was almost meteoric up to 1921 when her output (variously estimated at 193 to 202 million barrels) equalled the entire world's production in 1903. In 1905, before Mexico reached the million mark, the United States alone controlled over 62 per cent of the world's current yield. In 1911, when Mexico produced 12.5 million barrels, and ranked third for the first time, the two republics con-

† These four regions are more or less similar in the age and quality of the oil, it being mainly used in direct competition with coal as fuel for railways, steamers, etc., and for making gas. Some is cracked into gasoline. Considerable lubricants have come out of grade A Gulf oil and the lighter California oils. Of late years the latter has proven twice as rich in gasoline content as the average oils from the other three regions.

tributed 68 per cent. In 1918 Russia lost second place to our neighbor,* sixteen years after losing first place permanently. The following table shows how the two border republics improved their joint position from 1916 to 1923 when they controlled exactly seven-eighths of the world's output of petroleum. Altogether, during the 10 years, 1916-1925, the two supplied 84.3 per cent of 7,400 million barrels.†

Year	Millions of barrels				World pct.	Year	Millions of barrels				World pct.
	U. S.	Mexico	Total				U. S.	Mexico	Total		
1916.....	300.8	40.6	341.4	74.0	1921.....	472.2	193.4	665.6	87.0		
1917.....	335.3	55.3	390.6	78.7	1922.....	557.5	182.3	739.8	86.0		
1918.....	356.0	63.8	419.8	83.4	1923.....	733.3	152.0	885.3	87.5		
1919.....	378.4	87.1	465.5	84.0	1924.....	720.0	141.0	861.0	84.5		
1920.....	443.4	163.5	606.9	87.3	1925.....	764.0	116.0	880.0	82.0		

Panuco The Premier Field at Present. Cacalilao was not found before late 1922 but by the end of 1923 had produced about 45 million barrels of heavy oil. It reached its peak in 1924 with an output of 69.4 million barrels. Being considered merely a northern sector or extension of Panuco proper, the latter is generally credited with Cacalilao's output. Panuco contains other outliers and is an extensive area or composite field not comparable with the small and single pools listed below under the southern, or light oil district. The latter, centering about 60 miles south of Tampico, lost its leadership in May, 1923, when the heavy oil district forged to the front. The inevitable salt-water invasion began in 1921, and in 1923, the yield of light crude fell off by the enormous amount of 74 million barrels from the 1922 total of 138 millions. This loss in a single year exceeded twice the peak production of either Illinois, Louisiana or Pennsylvania.

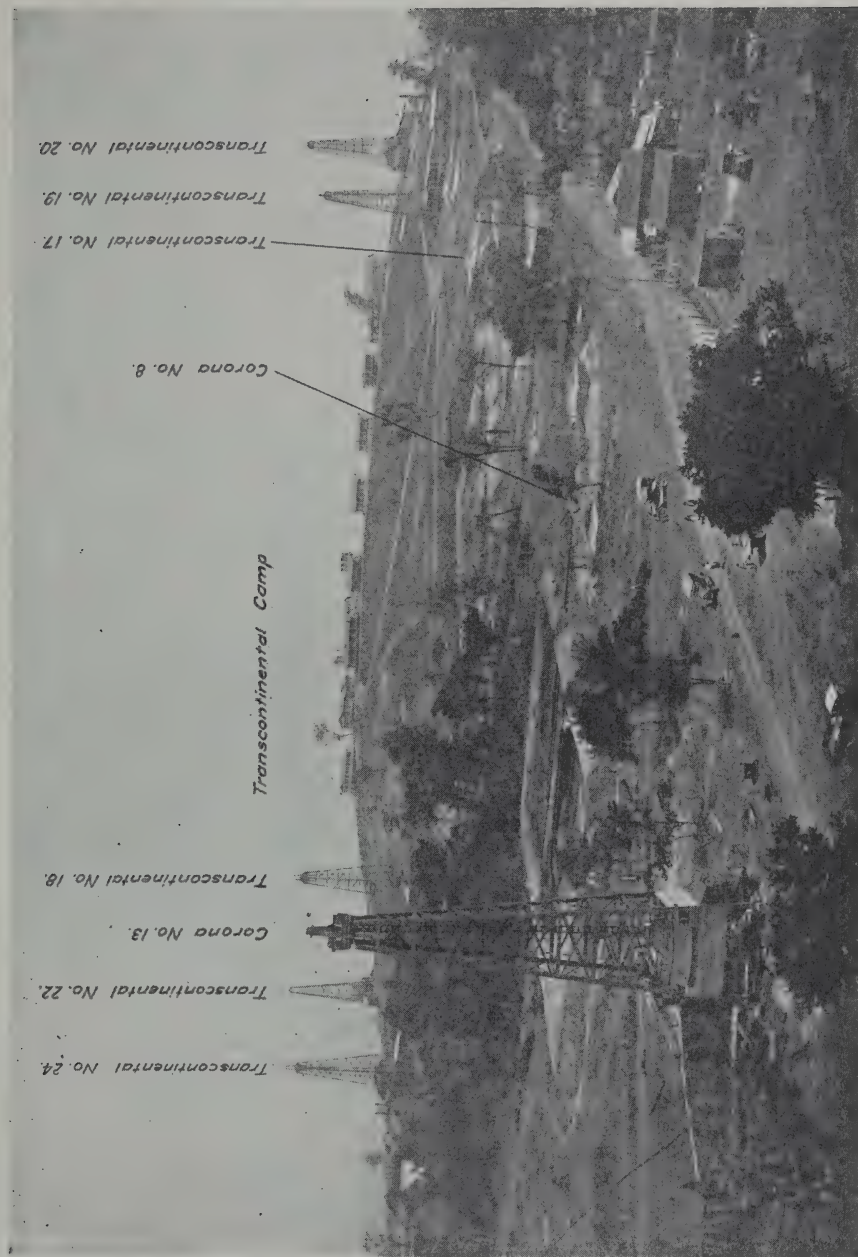
OUTPUT OF MEXICAN PETROLEUM FROM NORTHERN FIELDS AND SOUTHERN POOLS IN 24 YEARS

Area, Field or Pool	Year of discovery	Production in million barrels		Total
		To the end of 1923	During 1924 to 1925	
Panuco (including Cacalilao).....	1910	270	93	363
Ebano (including Chijol).....	1901	28.4	6.3	34.7
Topila.....	1910	14.1	1.2	15.3
Miscellaneous.....		4.5	.1	4.6
Total northern or heavy oil.....	1901	317.0	100.6	417.6
Lower Chinampa (incl. Northern Amatlan and Los Naranjos).....	1913	238	11	249
Casiano-Tepetate.....	1910	138		138
Toteco (Cerro Azul).....	1921	134	6.1	140.1
Potrero del Llano and Alazan.....	1910	111	0.6	111.6
Cerro Azul proper.....	1916	73.3	76.3	779.6
Alamo.....	1913	41	14.6	81.6
Tierra Blanca—Chapapote Nunez.....	1921	26		
Miscellaneous ‡.....		22.5	.2	22.7
Total southern or light.....	1910	783.8	38.8	822.6
Total, all Mexico.....		1,100.8	139.4	1,240.2

*One naturally wants to know why it was possible for a new industry to spring up so suddenly and especially to expand during a long period of political unrest and industrial depression. One reason may be found in the geographic location of the oil fields in almost uninhabited jungle and not very distant from tidewater. Another is suggested by the nature of the two principal transportation methods—buried pipe lines and open barges, both safer from attack than trains of tank cars. Still another was the need of revenue by the ruling party, and this was more easily provided the encouragement and protection of an industry which could quickly and profitably dispose of its products even though the whole world might be at war.

† This percentage is approximated in the iron ore production of the United States from Minnesota and Michigan together or in the world steel production by the United States, Great Britain and Germany.

‡ Includes Zacamiztle, with 1,000,000 barrels, to the end of 1924; Chicincillo, San Geronimo and San Miguel, 6,000,000 barrels; Furbero, Tanhujo, etc., hardly 2,500,000 barrels; Capoacan and the rest of the Isthmian or Tehuantepec pools, not quite 3,000,000 barrels, besides a few thousands from Chiapas and Tabasco. In addition to the above commercial production there was burned about 30,000,000 barrels during the Dos Bacas disaster. Total, Tampico-Tuxpam, 1,237 million barrels.



THE CACALILAO SECTOR OF THE PANUCO FIELD SHOWING EARLY DEVELOPMENT, 1922-23, BY THE STANDARD OF N. J. (TRANSCONTINENTAL) AND THE ROYAL DUTCH-SHELL (CORONA)

From development to January 1, 1926, leading heavy oil pools produced as follows: Panuco, proper, 264.2 million barrels; Cacalilao, 158.6; Tulillo-Chapacao, 55.1; Topila, 15.6. The light oil pools supplied the following quantities: Lower or Southern Chinampa, 178.6 million barrels; Casiano-Tepetate, 145.7; Toteco-Cerro Azul border, 144.7; Potrero del Llano, 100.3; Cerro Azul, 87.6; Southern Amatlan, 69.8; Alamo, 42.6; Tierra Blanca, 39.5, and Chapapote Nunez, 13.1 million barrels.—Blardone's special to The Wall Street Journal, March 5, 1926.

Daily Yield Diminishing During 1925. Salt water was steadily intruding in the Cacalilao, Chapacao and Coreovado whence the greater part of the oil came in 1925. From the 1925 peak of nearly 400,000 barrels daily during the week ended April 18, production had dropped a little below 300,000 barrels daily during the last week of June. The highest rate was reached late in 1921 when Toteco swelled the total to 700,000 barrels daily. This stupendous figure will stand a long time before approached by the peak production of any other foreign land. California alone among the states has ever surpassed this record, having reached the daily average of 872,000 barrels during the weeks ended August 11 and August 18, 1923. During the first half of 1925 output aggregated 65 million barrels, two-thirds of which was of heavy or Panuco grade.* This was but 5 million less than half of the 1924 yield. Nevertheless, as already noted, there had more recently occurred a rapid drop of 100,000 barrels in daily rate of production, all within ten weeks up to the end of June, 1925. As indicated, the decrease is due largely to natural causes, but some of it has been ascribed to a conservation policy of the Pan American Petroleum & Transport Co. (Eastern) which is now controlled by Standard of Indiana. This leading producer of Mexican Crude is said to be saving the latter for future use by drawing heavily on the abundant Smackover oil for its Destrehan refinery in Louisiana. Although most of the other producers have nearly exhausted their known reserves, Mexico must still contain immense quantities of unmined oil not only within the owned or leased lands of a few companies but also within a huge and promising territory yet untested.†

Decline Continued in 1926. Between January and December, daily production of Mexican crude oil declined 111,500 bbls.—from 306,091 to 194,547 bbls. The year's total approximated 90 million bbls.—25 million less than in 1925.‡ While output thus fell off over 21 percent, exports of all mineral oil declined about 18 percent—from about 100 million bbls. in 1925 to 82 million in 1926. The principal destinations in 1926 were: United States, over 65 percent; England, 16.6; Cuba, 6.1; Canada, 2.8, and Porto Rico, 2.4. The total value of all petroleum exports diminished 27 percent—from 171,164,000 in the first half of 1925 to 125,465,000 pesos in the first half of 1926. Decrease is attributed to the drainage of many wells and the absence of extensive drilling since the promulgation of the new oil laws. Up to November 1, a total of only 291 productive oil wells were completed during 1926 (compared with 17,415 in the U. S.). In five years the average initial yield of Mexican wells has dropped from over 6,000 bbls. to about 600 bbls. daily. Meanwhile the dry hole hazard has ascended so that now hardly 1 out of every 3 holes drilled is rated a commercial producer.

WHO'S WHO IN MEXICAN PETROLEUM

Prominent Producers in Mexico. Pan American Petroleum & Transport Co. (Eastern), through its secondary subsidiaries, the Huasteca Petro-

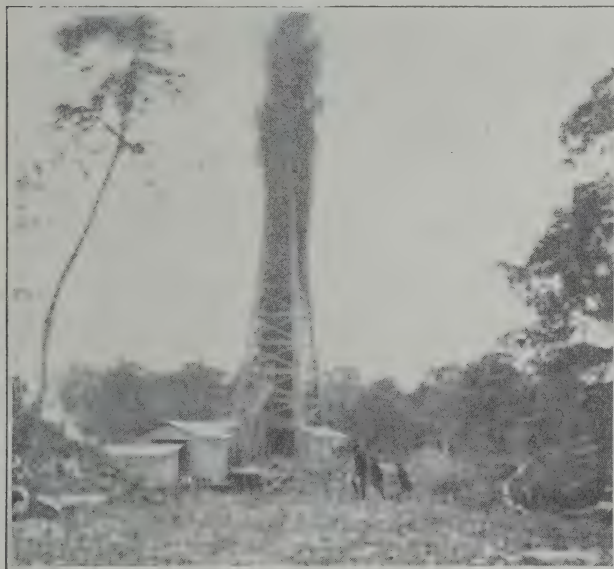
* Only a few years ago it was the other way around, so that of the total to the end of 1924 there was almost exactly twice as much so-called light oil as of heavy oil produced in Mexico.

† "Mexico is no longer a menace to the American producer, nor is it likely to become so, though there probably will be new fields discovered comparable with those already known. This condition has been brought about as largely by the development of facilities for increased consumption in the United States as by the decline in Mexican production." —E. DeGolyer in "Transactions of the Am. Inst. of Min. and Met. Engrs.," 1923. See "No Immediate Threat from Foreign Oil," L. M. Fleming in the *Oil and Gas Journal*, October 30, 1924. Mexico's output in 1926 approximated half that of Oklahoma, or two-fifths that of California.

‡ The yearly rate at the beginning of 1927 was hardly 70 million bbls., or less, than that of the Gulf Oil Corp., or not quite one-eleventh that of the United States.

leum Co., operating mainly in the light oil district, and the Mexican Petroleum Co. (of Calif.), operating around Ebano (both immediate subsidiaries of Mexican Petroleum Co. (of Del.) is by far the foremost producer of Mexican Oil. Standard of Indiana, through its recent purchase of Pan American, has therefore twice as much Mexican production as Standard of New Jersey has through its control of Transcontinental and Penn Mex Fuel Co. In the table below the individual companies* are arranged in order of their output for 1925, the figures representing millions of barrels.

Company	1925	Total	Company	1925	Total
Mexican Petroleum	37.37	343.82	National Railways	2.30	3.29
Transcontinental	20.62	116.83	Atlantic Gulf & W. I.	1.30	35.91
Mexican Seaboard	12.66	76.81	East Coast .....	.99	31.98
Royal Dutch	9.31	97.56	The Texas Co. ....	.86	42.00
Sinclair	7.97	69.56	Penn.-Mex. Fuel .....	.55	44.58
Mexican Eagle	6.54	218.72	Island Oil .....	.53	24.72
Gulf Oil	6.49	97.74	New England Fuel .....	.51	26.72



**MEXICAN
PETROLEUM
COMPANY'S
GUSHER IN
TIERRA BLANCA,
1925**

Gushers gauging 25,000 to over 75,000 barrels daily are still being brought in on the former Doheny holdings in the Southern fields, where the Pan-American Company retains huge oil reserves.

—Pan Am. Petrol. & Transport Co.

Eleven companies contributed 86.4 per cent to the total of 140 million barrels produced in 1924. The Texas Company and 64 others, each contributing less than 2 per cent, made up the balance.

The eleven leading producers in 1925, including The Texas Co. of Mexico, supplied 92 per cent of the total, 115.7 million barrels. This indicates a drift towards centralization. Standard of Indiana and Standard of New Jersey together controlled 51 per cent of the total in 1925. Of 37.6 million barrels of light oil produced in 1925, Pan American furnished 58.3 per cent, Mexican Eagle 16.4 per cent, and Gulf Oil 7.4 per cent; a total of 82.1 per cent for the three. Of 78.1 million barrels of heavy or "Panuco" oil, it took five companies to contribute 81.1 per cent: Transcontinental (25), Mexican Petroleum (19.8), Mexican Seaboard (15), Royal Dutch (11.3), and Sinclair (10),

* Of the total (1,350 million barrels) to January 1, 1926, Mexican Petroleum is credited with 25.5 per cent; Mexican Eagle, 16.2 per cent; Transcontinental alone, 8.6 per cent, or with other Standard of N. J. subsidiaries, about 18 per cent; International or Mexican Seaboard (Hammond interests), 5.7 per cent; Gulf Oil (Mellon interests), 7.2 per cent; Royal Dutch-Shell alone, 7.2 per cent, or as a group (including Mexican Eagle and Oilfields of Mexico), about 24 per cent; Sinclair, 5.2 per cent.

SECOND WELL, TOTECO- CERRO AZUL POOL

Toteco No. 1, of the International Petroleum Co., operating subsidiary of Mexican Seaboard, shortly after it came in. Before shut in the roaring gas was heard by the author at a distance of half a mile. Note the valve anchorage and B. E. Hull at left; at right, R. C. Holmes, now president of The Texas Co., 1926. Initial yield of this well, 2,038 feet deep, was 60,000 barrels; total in 16½ months to July 1, 1922, was 10,219,000 barrels or 7 times that of the discovery well, Toteco No. 1 of the Mexican Gulf Oil Co., which came in February 9, 1921, with initial of 14,000. The third to share in this world record pool for daily production (516,000 bbls., on December 22, 1921) was the Huasteca Petroleum subsidiary of Pan American Pet. & Transp. Co. Its first well, of 75,000 bbls. initial, produced 15,218,000 bbls. in 12½ months.

—Texaco Star



Shipments Show Decided Decline. During the past eight years from 80 per cent to more than 95 per cent of the oil produced in Mexico has been exported. Tanker shipments keep close pace with production, and thus the following table reflects the recent and continued falling off in output of crude oil.* The figures stand for millions of barrels. To obtain the quantities exported, the bunker oil and coastwise (domestic) shipments have been deducted:

Month, 1925	Shipments	Exports	Month, 1925	Shipments	Exports
January	11.05	9.91	April	9.58	8.71
February	10.00	9.20	May	10.10	9.43
March	11.42	10.01	June	8.90	7.92

The marine movement aggregated 61 million barrels in the first half of 1925 or 10.5 million less than in the corresponding period of 1924. It amounted to 133.8 million in all of 1924 compared with 143 million in all of 1923. The maximum movement occurred in 1922 (the year after peak production) when 181 million barrels were taken away by tankers. Excluding bunker fuel (6.8 million) the shipments of 127 million barrels in 1924 consisted of 63 per cent crude and 37 per cent topped oil and distillates.

Share of The Leading Shippers. In the accompanying table some noteworthy changes appear. The Mexican Petroleum Co. (former Doheny interest) decreased its exports more than 3.5 million barrels because of entering the Mexican gasoline and kerosene market, whereas, before 1924, virtually all of its production was sent out of the country. Loss in production of Panuco oil explains the loss of over 6.5 million experienced by

* Shipments continue declining, in the 31-day month of July, 1925, amounting to only 8,440,000 barrels. To maintain shipments without greater loss during the past 18 months a little oil was moved from stocks which (including crude, fuel and distillates) decreased from 22.5 million barrels on January 1, 1924, to nearly 19.7 millions on January 1, 1925. Shipments fell off further in 1926, being but 5.4 million bbls. in November compared with 6 million in October, and the average of 7 million bbls. per month up to November 1. As usual, Huasteca or Mexican Petroleum (Pan-Am. P. and T.) led with 36 per cent of the combined October and November shipments.

"La Corona," the Dutch Shell subsidiary. The greatest proportionate drop was that of The Texas Co.—64 per cent of its 1923 shipments. Flush production early in the year from heavy oil holdings in Cacalilao enabled Gulf Oil Corporation to ship 3.75 million barrels more than in 1923. Similarly, Mexican Sinclair and Empire Gas and Fuel companies enjoyed good gains. The quantities represent millions of barrels.

Shipping Company	1924	1923	Shipping Company	1924	1923
Transcontinental	29.9	17.7	The Texas Co. of Mex.....	3.1	8.7
Huasteca	28.4	32.0	New England Fuel.....	2.0	3.6
Dutch Shell	16.6	23.1	Mexican Seaboard	2.2	3.7
Mexican Eagle (Aguila)	14.6	18.1	Atlantic Gulf (Agwi).....	1.1	3.2
Mexican Sinclair	11.8	9.7	Panuco Boston .....	.9	.5
Mexican Gulf	11.6	7.8	Unity .....	.8	.7
East Coast (S. P. Ry.).....	5.0	7.2	Pierce Oil .....	.7	.9
Empire Gas & Fuel.....	3.5	2.4	Interocean .....	.7	.6

During the first half of 1925 Huasteca (or Pan American Eastern) resumed its leadership with exports of 20.3 millions, or at the annual rate of 40.6 millions. This marked a gain of 5.1 millions over the first half of 1924. Standard of New Jersey similarly increased 1 million and Mexican Eagle almost 3 million barrels. The other important companies registered losses ranging from 1 to 4.2 millions, the maximum by Mexican Gulf, during the first half of 1925.*



—The Texaco Star.

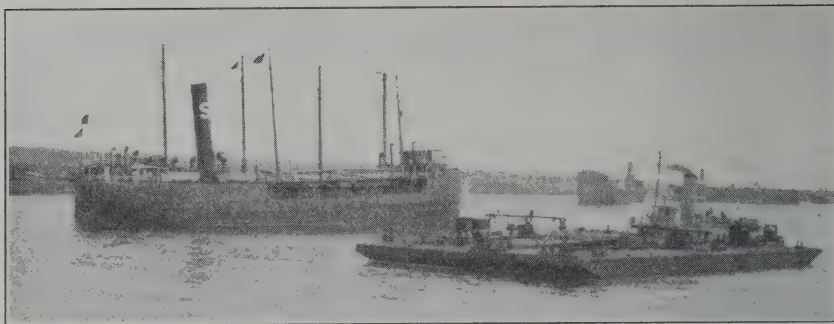
BARGING CREW AND SUPPLIES ACROSS THE PANUCO

This shows how low and swampy most of the land appears in the Panuco field through which this navigable stream meanders leisurely "a la mañana."

TAMPICO—TREASURE TOWN OF MEXICO

World's Most Exclusive Oil Port. Tampico is the queen of seaports in the southern republic. Petroleum has enthroned this Cinderella of Mexican cities.* In less than a quarter century it has become, moreover, the metropolis of oildom outside of the United States. Los Angeles harbor

* At the beginning of 1927, Huasteca was producing 58 to 60 per cent of the light Mexican oil and 33 to 34 per cent of the heavy, shipping around 40 per cent of the total exported. Next in production (and shipments) was Standard of N. J.; third, Mexican Seaboard; fourth, Royal Dutch-Shell; fifth, Mexican Eagle; sixth, Gulf Oil.



—Photo by author, 1921.

TAMPICO HARBOR. SHOWING STANDARD OIL TANKER (LIGHT) AND BARGES (LOADED WITH OIL BROUGHT FROM THE PANUCO FIELD FOR TRANS-SHIPMENT)

alone of all the world's ports has ever surpassed Tampico in tonnage of oil shipments. In value it does not show up so well since the big bulk of the liquid is shipped unrefined—63 per cent as crude and most of the rest as topped crude in 1924.

Due to favorable railway rates from the interior, placing her on a par with Vera Cruz, the second seaport, and due to her strategic situation, half way between Matamoros (opposite Brownsville, Texas) and Vera Cruz, Tampico now dominates the export trade with the United States—to the extent of 50 per cent in 1923 and 63.5 per cent in 1924. The actual values were \$70,700,000 in 1923 and \$106,000,000 in 1924. The exports included, besides petroleum, ixtle fibre, sisal fibre, hides and chicle. The imports, worth not nearly so much as the exports,* included immense quantities of pipes and fittings, oil field and mining machinery, autos and trucks, as well as minor amounts of general merchandise. The importance of Tampico to the United States is emphasized by the fact that three-fourths of Mexico's foreign commerce is carried on with out country.

Rivals Arose to Relieve Tampico's Congestion. In the matter of oil shipments Tampico was obliged to share rather heavily with "mushroom" competitors during a decade.† From 1912 to 1922 not quite 35 per cent of Mexico's marine movement of oil was out of Tuxpam and Port Lobos, the

* The history of Tampico begins in 1823. It was a straggling village of humble, scattered huts, without any commercial importance. A more ideal townsite could not have been found on the Gulf coast. Situated only six miles from the sea, and on the higher north bank of the Panuco just below its junction with the Tamesi, Tampico is in sight of the broad bosom of the Gulf and gets the benefit of its health-giving breezes. The rolling tract of land on which it is located enjoys natural drainage. * * * The Mides touch of oil transformed Tampico from a quiet, leisurely little town into a noisy, bustling burg of over 100,000 inhabitants.—*The Texaco Star*, March, 1921.

† * * * The phenomenal development of oil production taxed the T. harbor beyond its capacity. As the industry moved southward, Tuxpam became the logical shipping point; but the lack of a harbor for ships of size obliged the operators to install submarine pipe lines to loading berths out in the Gulf where tankers could load to capacity. In 1918, The Texas Co. established a terminal at Agua Dulce opposite Lobos Island, 70 miles south of Tampico. At the end of August, 1925, there was a shut-down, the last of several sea-loading terminals along the 18-mile stretch of the Gulf Coast from Tecamate to Agua Dulce in the State of Vera Cruz. These cost about \$34,000,000 and had a salvage value of \$4,000,000 when abandoned. At the height of production in 1921, from the "Golden Lane," as the light oil area was known, and when construction was at its height, 4,250 men were employed at the seven sea-loading stations and topping plants. At times there were as many as 48 tankers either loading at the end of sea lines or awaiting berths.—*Petroleum World*, August, 1925.

fluctuations being from 21 to 42 per cent. The 100 million barrels of petroleum which passed out of the Panuco river in 1921 made 57.5 per cent of the total shipments by water that year, the banner year in Mexico's production. Tampico bettered her share in 1922 when the 122.7 million barrels constituted 66.2 per cent of the total. Her first tanker cargo of crude left on May 20, 1911, and the total for that year amounted to less than 900,000 barrels. Her share that year was about 90 per cent, and with the abandonment of Port Lobos, beginning in 1924, Tampico is again more firmly seated in the saddle with a percentage of 97 for the half-year ended June 30, 1925. The topping plants at Port Lobos have also been shut down. Because of the failing quality of Mexican crude even some of the refineries at Tampico have closed. On January 1, 1923, seven plants along the Panuco could refine 300,000 barrels daily—85 per cent of the national capacity. This seaport, considered as a single city and not as a district like Los Angeles, has actually been supreme throughout the world in capacity for partial refining, that is, topping.‡

Uncle Sam The Biggest Buyer of Mexican Oil. Owing to its popularity as fuel oil Mexican petroleum during the past ten years has penetrated to many foreign lands, as many as 32 in 1922. The more important destinations for the vessel shipments in 1924 are indicated in the following table:

Destination of exports	Mill'n 1923	Bbls. 1924	Percent 1924	Destination of exports	Mill'n 1923	Bbls. 1924	Percent 1924
United States	96.5	89.2	73.3	Canada	2.4	1.2	1.5
United Kingdom	7.7	8.4	6.8	Panama	1.2	1.1	0.9
Cuba & West Indies	6.8	7.6	6.2	Central America	1.0	0.8	0.7
South America	7.2	6.7	5.5	All others	1.3	0.8	0.7
Continental Europe....	4.2	5.4	4.4				
				Total	128.3	121.8	100.

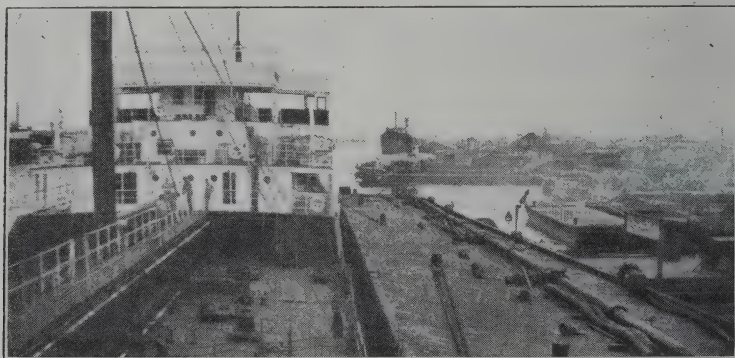
It will be noted that the United States generally takes three times as much Mexican oil as all the other countries combined. France, Italy and Germany were the leading Continental buyers in 1923, the first taking just one-tenth as much as the United Kingdom. In South America, Argentina in the same year bought 3.5 million barrels or almost as much as Brazil, Chili and Uruguay together. Total Latin American shipments of Mexican oil amounted to 16.2 million barrels in 1923 and the same in 1924. In the first half of 1925, the United States was the destination of 77 per cent of the shipments abroad and prosperous Cuba of 7.5 per cent or more than half again as much as the United Kingdom. In computing percentages both bunker oil and coastwise shipments to other Mexican ports were deducted from the total tanker shipments—133.8 million in 1924 and 143 million in 1923.

‡ According to *The Wall Street Journal*, which stated that the Corona refinery of 60,000 barrels capacity was closed and that the Transcontinental (20,000 barrels) was dismantling, presumably late in 1923.

According to U. S. Commerce Reports, November 16, 1925, there are 19 refineries in Mexico, of which 8 are topping plants with capacity of 268,042 bbls daily, and 6 are complete plants of 192,285 bbls. capacity; total, 461,390 bbls. There is also one plant preparing gasoline exclusively, and another producing asphalt alone. The total refining capacity is about 50 per cent in excess of current yield of crude. Of 140 million barrels produced in 1924, hardly 67.5 million was refined. Of the products, 64 per cent was fuel oil; 20.7 per cent crude and refined gasoline; 3.1 per cent kerosene; 1.4 per cent asphalt; 0.28 per cent lubricants.

According to U. S. Commerce Reports, February 8, 1926, exports of crude petroleum and products in 1925 approximated 96.3 million barrels out of 114.8 million produced having a value of about \$145,000,000 U. S. currency. Of the domestic production about 11.6 per cent was consumed in Mexico in addition to 1.8 million barrels of products imported, making the total consumption a little over 15 million barrels or 42 gallons per capita.

Meaning of Mexican Oil to Americans. Elsewhere it has been remarked what a factor Mexican fuel oil proved in winning the war. As bunker fuel in direct competition with coal it may remain the principal utilization because of its gravity.* The United States, to the end of 1925, has received from the southern neighbor somewhat over 825 million barrels of petroleum having a monetary value of between \$500,000,000 and \$600,000,000.† Ultimately and in various ways the derived products and the directly consumed crude were worth a great deal more to us Americans. For instance, our motorists must have indirectly appreciated the addition to their supplies of about 75 million barrels or nearly 3,200 million gallons of gasoline. Not only that, but without doubt the imports from which this motor fuel was refined did depress the price of the domestic product. No wonder, then, that Mexican oil proved obnoxious particularly to our Mid-Continent producers who once and again chorused a call for an import duty on foreign petroleum.‡ It appears that the high tide in the output of the Tampico district came concurrently with a period of enormous expansion in our own production. Low prices were bad enough for the oil business of the United States, but the worst feature of the over-production in North America was the encouragement of economic waste of a precious product. Altogether too much good fuel oil has been burned inefficiently beneath boilers instead of running Diesel and semi-Diesel engines.



—From photo by the author.

PAN-AMERICAN TANKER AT HUASTECA PETROLEUM COMPANY'S TERMINAL

This shows part of the loading pier on the south side of the Panuco, opposite Tampico, or about five miles from the gulf. Farther south is the large tank farm.

Significance to Our Southern Neighbor. While the world abroad has bought and burned nearly nine-tenths of all the oil produced* in Mexico, largely as fuel oil in place of coal, this combustible has signified a great deal more to the Republic than is apparent at first sight. Used originally

* *The Oil Trade*, July, 1925, reports that Pan American (Eastern) will install extensive cracking facilities in Mexico for getting a high gasoline recovery from its large production of low-gravity oil.

† In the six years, 1919-1924, 608 million barrels worth almost \$400,000,000 and increasing in value each year though decreasing in quantity.

‡ "No Immediate Threat from Foreign Oil—Menace of Mexico's Output Becoming More Remote" is the title of L. M. Fanning's article in *The Oil and Gas Journal*, October 30, 1924. See also similar contributions by Chas. E. Bowles, now Assistant Secretary Mid-Continent Oil & Gas Assn., Tulsa.

as fuel on her railways, Mexico's oil early cut down the nation's coal bill.* As a source of artificial asphalt it may be credited with paving several Mexican cities. In mining it has materially reduced the operating costs. In both volume and value, petroleum has ranked first among Mexico's minerals for seven or eight years. It is by far the foremost export, making up more than one-fourth of the total (increasing from 28 per cent of the value in 1923 to 35 per cent in 1924; the percentage being even greater in tonnage and in volume). It has brought \$600,000,000 foreign capital into the country and has provided employment to many peons. The oil industry has helped to create a higher standard of living, having the habit of paying good and steady wages.† Tampico, almost entirely dependent on petroleum, has risen from a hamlet of huts to a modern municipality of more than 100,000 inhabitants and with handsome suburban "colonies" occupied by oil men and their families. It has become, through oil alone, the leading seaport of the Republic. Though suffering itself from the inroads of revolutionists and brigands, the Mexican petroleum industry has promoted stability in Government through the payment of liberal taxes. Its major development came at a critical time when enforced idleness in other industries, notably in mining, cut off sources of Federal revenue.

MEXICO'S NIGHTMARE OF NATIONALIZATION

True Cause of Curtailment in Output of Crude. As in California, the oil deposits in Mexico are limited in area and extremely localized. In order to find new ones it is necessary to drill many dry holes. This risk has lately increased to more than 60 percent or three times the dry-hole hazard in the United States. The average initial and the average settled production have also slumped. Thus the costs of discovery and of producing have climbed to a high level. The production rate, however, would not have fallen off so fast, 50 percent in five years, if the Mexican Government had encouraged the spending of greater sums in finding and developing. The experience of the Transcontinental, subsidiary of the Standard Oil Co. of N. J., is a case in point. It desired to explore for new reserves but could not because the government had failed to adopt a fav-

* Of more than 12,000,000 barrels of oil kept for domestic consumption (per capita of about four-fifths barrels or 32 gallons) during 1924, about 6,000,000 went to interior markets and the rest to railways and for field use. This is equivalent to about 3,500,000 tons of coal, which at \$8 a ton would have a value in Mexico of \$28,000,000 or more than 56,000,000 pesos.

† Aside from the revolutionary interruption in 1915, the petroleum industry has constituted the *only consistently active and reasonably prosperous basic industry* (for many years), although the year 1921 and the first half of 1922 saw many wide (and) variations in Mexican oil, according to the Latin American Division of the U. S. Dept. of Com. (Supplement to *Commerce Reports*, No. 20, 1922). During the oil boom, and up to early 1921, industrial and personal receipts had been on a very liberal scale. During the early Summer of 1921, a surplus of fuel-oil stocks following the discovery of the great Toteco pool in February (1921) and of the Southern Amatlan-Zacamixtle in October (1920), and following also a decrease in demand owing to a general depression in the world markets, *forced the price* from a range of 40 to 50 cents a barrel *down to a minimum of 10 cents a barrel*. All construction programs were stopped, and contracting companies were forced out of business. Later came the great fire at Amatlan, the salt-water invasion of the wells, and controversies with the Government over taxes which caused further suspensions. During the period of low prices, more than 20,000 Mexican laborers in the oil fields were laid off and compelled to leave the district on account of high living costs. All this reacted on the commercial interests. The purchasing power diminished; orders for new goods were withdrawn; stocks ran low, and only small supplies of necessary staples were imported. Imports from the United States dropped from \$222,000,000 in 1921 (mostly received in the first half) to hardly \$110,000,000 in 1922.

orable petroleum law permitting investments for continued development.*

Navigating Towards Nationalization. During the last few years the Federal Government has drilled on its railway right-of-way through producing oil land and much nearer private property lines than is usually permitted in the United States. Thus the government has come into competition with the Mexican oil industry from which it has collected production and export taxes totaling 43 million dollars (U. S.) in 1922, 30.5 million in 1923, 27.5 million in 1924 and 21 million in 1925. Since the adoption in 1917 of the present constitution the government has striven to nationalize the subsoil. In 1918, the producers, supported by their home governments, successfully resisted the government's efforts to exact rentals and royalties on top of those paid to the private owners additional to the increasing taxes and tolls then being variously obtained.

Confiscation Threatened Under New Law. Late in 1925, an oil law was enacted, effective January 1, 1927. It affirmed the nation's ownership of the subsurface oil and provided for government concessions to confirm rights procured up to May 1, 1917. The new law accords with the famous Article 27 of the Carranza Constitution in denying the right of foreign companies to acquire concessions. To the many important producers who do not hold Mexican charters the new law has proven particularly embarrassing, none the less because the form of confirmation was not announced until December 26, 1926, although they were expected to apply before December 31, 1926, under threat of confiscation of the land which they had paid for.

Mexican Court Justice versus Intervention. Apparently this dispute between the Mexican Government and American and foreign oil companies has settled down to a court fight. Mexico's Foreign Minister has actually invited them to seek redress in Mexican courts. But the operators have misgivings in view of the personnel standard of the Supreme Court † and of the miscarriage and procrastination of justice in the case of the late Mrs. Evans whose home was taken from her after the murder of her British husband. The Texas Co.'s "amparo" case is another illustration. The fifth favorable decision was nullified with the passage of the new law in 1925. The foreign operators do not desire arbitration since this procedure might recognize the right to confiscate their properties. The United States Government has intervened and even "invaded" at times when lesser values or principles have been involved.‡

*All drilling in 1926, as previously, was done on land from the surface owners of which the subsoil rights had been acquired under laws in force before the Carranza Constitution went into effect, May 1, 1917. These were similar to those of the United States and all operations of the Transcontinental were performed under contracts with the owners who received rentals and royalties at rates approximating those paid here. See *Oil & Gas Journal*, March 3, 1927; also, *The Lamp*, February and October, 1926.

† No one is qualified for a judge of this court if he has been convicted of any offense punishable with more than one year's imprisonment. See *Wall St. Jnl.*, Jan.-Feb., 1927.

‡ See Marcossion in *The Saturday Evening Post*, March 5, 1927, also the *Public Ledger*, March 1, 1927. Following are facts from American records: Of Mexico's 90 million bbls. of oil produced in 1926 about 76 percent was by the 22 concerns listed by President Calles as recalcitrant. More than 148,000 Americans are stockholders in these companies and their investments have been estimated at \$350,000,000 to \$500,000,000. They declined to give up legal titles obtained prior to 1917 for revocable concessions. The remaining 24 percent of Mexico's production represents some companies which had applied for concessions.

Asked *The Lamp* in the fall of 1926: "Now the story is told, has Mexico reason to regret the entrance of the oil companies with their hundreds of millions for development, operations and taxes? When it is realized that out of every \$3 received for Mexican oil, \$2 stayed in the country (\$1 to Mexican labor and \$1 to tax collectors), the talk of exploitation of a helpless nation by foreign capital can be valued at its real worth." See also *Los Angeles Times*, Dec. 7, 1926, and *U. S. Commerce Reports*, Apr. 18, 1927.

CHAPTER XI—GOVERNMENTAL RELATIONS

OUR FEDERAL GOVERNMENT THE GREATEST OIL LAND OWNER, LESSOR AND CONSUMER OF PETROLEUM PRODUCTS

"We have had many attempts at regulation of industrial activity by law. Some of it proceeded on the theory that if those who enjoy material prosperity used it for the wrong purpose, such prosperity should be eliminated and abolished. This is as sound as it would be to abolish writing to prevent forgery. We need to keep in mind forever that guilt is personal; let us not condemn the instrument but the evil doer."—CALVIN COOLIDGE.

"We could not ignore the Government as a real factor, or, because of its interest as a consumer, merge it with others in that category, for it is undeniable that the policies of Government, state and national, are important factors in our weal or woe, and the success and perpetuity of the Government itself depends largely upon the course of its industries.—AMOS L. BEATY, Chairman of the Board, The Texas Company.

Manifold Federal Relations. More varied and extensive relations to the oil industry are maintained by the American Government than by any other government, such as that of either Mexico or Russia, where tragic nationalization* has been practiced in diverse degrees. The administrations in these two countries are primarily concerned with the government income that may be procured and not with the true prosperity of any private petroleum industry. Considering that the big bulk of the present production in the United States is derived from lands once part of the public domain and that our Government cooperates in finding oil and in avoiding wastes of all kinds that are detrimental to the legitimate industry, it may be correctly claimed that our Government contributes more than it takes. The Federal Government, that is, the people of the United States, is the greatest owner of oil lands, at least within our own national boundaries; it is the leading lessor, receiving royalties from oil, gas and natural gasoline in the fiscal year ended June 30, 1925, exceeding \$15,000,000; it acts as an advisory geologist and engineer; it is preeminent as a petroleum economist; it not only supervises the production from Indian lands but through the Supreme Court has directly operated oil wells on lands whose ownership has been in dispute (Red River boundary between Oklahoma and Texas); it is the world's biggest buyer and consumer of petroleum products; it is the foremost publisher of literature on oil and gas, and it is outranked by the republic to the south alone as the champion collector of taxes and tolls on the output and traffic in petroleum (see Panama Canal and page 19; also Treasury Dept.).**

Reasonable Regulations Good for the Industry.† There are a few places where uniform regulations, worked out by those familiar with the subjects, would be salutary. One of these is where the producer in his greed commits waste at the well or in storage. We need rules of conduct and an

* Paralleling every argument against Government operations is one insistent note. That is the preservation of the vital initiative and enterprise of our people. Government can correct abuse without entry into business. If it can not, then democracy shall have failed.—HERBERT HOOVER, quoted in *Oil Bulletin*, January, 1925.

** Publications of the Department of Labor, the Federal Trade Commission and the Interstate Commerce Commission have been quoted elsewhere to indicate their relations to oil. See page 171 re the Government tanker fleet which made 12 percent of all American tanker tonnage in 1924; see also page 255 re retained tankers of about 400,000 tons capacity on January 30, 1926.

† From address of Amos L. Beaty before the Ft. Worth meeting A. P. I., December, 1924.

umpire of the game at these points. There is nothing radical or alarming in the idea. Some of the oil producing states have taken notice of wasteful practices and have acted to prevent them. In many cases the enactments have been crude and sometimes unworkable. This has been due to the fact that those skilled in the business did not take the lead or point the way. Town-lot drilling and line crowding are things to fret about.

Doubtless something on that score might be done. It is an outrageous species of competition, worse than selling below cost, to force one to drill a well to each acre where a well to ten acres would do. Among serious operators there is no difficulty on account of waste of oil or overdrilling. They usually rise to the occasion and do what is right; it is the reckless operator, usually a stock selling promoter, that needs curbing.

Activities that Benefit Both Business and Consumer. What is truly good for the Government is indirectly, as a rule, also beneficial to both producer and consumer, as detailed later on. Inquisitorial hearings, however, invariably irritate the honest operators and rarely prove of any permanent value to the public. They often interfere with proper cooperation for the common welfare as in the conservatism of capital and the prolongation of natural resources. The oil industry as a whole resents particularly any uncalled-for Congressional attacks and the interference of the Federal Trade Commission.* On the other hand† the industry welcomes the valuable services of the Geological Survey, the Bureau of Mines, the Bureau of Standards and the Bureau of Foreign and Domestic Commerce. Their activities advance the interests of both producer and consumer since they consist of research in the field and laboratory; the assembly, study and distribution of useful statistics; the promotion of commerce in mineral oil; and the investigation of and advising on methods and equipment that may increase recovery in field and refinery and often lower costs. The legitimate industry and the public are pleased with the efforts of the Justice and Post Office Departments to discourage dishonest promotions. The industry especially is appreciative of the purpose, spirit and operation of the Federal Conservation Board.‡

What Congress Has Accomplished. The first session of the 69th Congress, ended last July (1926), passed its major measure for the benefit of the oil business, but this was vetoed by President Coolidge. It would have solved the vexed problem of oil leases on Executive-order Indian reservations. Had the bill become law it would have accomplished five purposes: (1) Permitted exploration for oil and gas on reservations (of about 23,000,000 acres) not created by act of Congress; (2) given to the Indians all of the oil and gas royalties; (3) authorized the states to tax the production of oil and gas on such reservations; (4) extended relief to permittees and applicants who have in good faith sought to discover oil and gas under the general leasing act of February 25, 1920; (5) removed the necessity for further litigation in the courts concerning the leases under which, while they were in effect, valuable discoveries of very light oil were made on the

* See *The Texaco Star*, May, 1924.

† "Cooperation of the Federal Government in Discovery and Production of Petroleum," by E. C. Finney, before A. P. I. meeting, Chicago, December, 1921.

‡ The Government furthermore creates investments opportunities through the leasing of public oil lands. See *Magazine of Wall Street*.

Navajo Reservation in New Mexico. The only bill enacted for the good of the oil industry was that of Senator Ralph Cameron, of Arizona. Under its terms any oil or gas prospecting permit issued under the act of 1920, or extended under the act of 1922, can be further extended for two more years by the Secretary of the Interior under certain conditions.§

How Oil Has Helped the Government. Elsewhere, at the end of Chapter XII, it has been pointed out how the petroleum industry, through its leaders, not only refrained from profiteering during the war but also contributed the great essential in the way of mechanical power which more than man power procured the victory. It has contributed to the economy and efficiency in the operations of the National Defense on land and sea and in air and water. Without automobiles, peace-time government would be slower. Gasoline has greatly simplified the transmission of documents. Airplanes cross the continent under the auspices of the Post Office De-



OUR GOVERNMENT PROGRESSIVE

Uncle Sam's mail service by airplane is proving a valuable aid to American business. The saving in time means quicker turn-over of capital and gains in other ways.

Thus the Post Office Department is a consumer of aviation gasoline as well as motor fuel for mail trucks. Army and Navy planes likewise consume light fuel.

—Standard Oil Bulletin.

partment in hours instead of days. Motor cars make it possible for messengers to make The White House and return to The Hill in less than 15 minutes.* Oil has contributed heavily to the financial support of both State and Federal governments, and indirectly, through the gasoline tax in about 45 states, has built paved roads and permanent bridges (see below and Chapter XIII). Oil executives have assisted in introducing better business methods in Government administration, notably in establishing and building up the budget system.

Treasured Income versus Tragic but Trivial Losses. Not ignoring such minor episodes as the escape of the elusive liquid from a naval oil reserve before its partial and delayed capturing,† it may be conservatively said that treasures derived by the Federal Government from oil and the oil industry measure more than ten times the tragedies entailed. Looking at the

§ Abstract of article by Geo. H. Manning in *The Oil Trade*, August, 1906. See also page 21, *The Oil and Gas Journal*, April 24, 1924, article by L. M. Fanning.

* See *The Lamp*, April, 1922, inside back cover.

† Referring to E. L. Doheny's meritorious enterprise in drilling wells in the Elk Hills district for the Navy Department and in constructing essential storage in the Mid-Pacific. See editorial page, *Oil City Derrick*, May 1, 1925. Court evidence apparently convinced the jury at Washington just before Christmas, 1926, that Mr. Doheny's motives were primarily patriotic.

matter from the mere money side, the Federal Government has found the petroleum branch of the mineral industry the most profitable or "plum bearing." Government income from taxes on the net earnings and excess profits of oil companies was almost \$40,000,000 in 1919 (page 19) or before the leasing law went into effect. Such income tax collected by the Bureau of Internal Revenue amounted to \$94,500,000 in 1920, dropping below \$22,700,000 in the dolorous year 1923 when the oil industry was in distress despite the removal of the excess-profits tax. The Federal tax totaled \$36,400,000 in 1924, according to the latest published report of David H. Blair, Commissioner of Internal Revenue.† Federal taxes and royalties combined for the year 1925 may be estimated at a sum considerably greater than \$50,000,000. Royalties alone approximated \$15,000,000, but only 10 percent thereof reverted to the U. S. Treasury after allowing 37½ percent to the states within which the oil and gas were produced and after diverting 52½ percent to the reclamation fund for use in western states. Wyoming, with its Salt Creek field owned almost entirely by Uncle Sam, received 86.2 percent of the 37½ percent paid back in the fiscal year ended June 30, 1925; California, containing Naval Reserves Nos. 1 and 2, received 10.8 percent; Montana, Colorado and Utah received most of the remaining amount.§ The Government gathers no duties on the importation of petroleum although Mid-Continent producers have clamored for a protective tariff on Mexican crude oil; but considerable revenue (over 40 percent of the total in one year) has been received as tolls on the tanker traffic through the Panama Canal.

DEPARTMENT OF COMMERCE AND BUREAU OF MINES

Commerce Contact with Mineral Matters. Since a mining engineer became Secretary of Commerce, Government business pertaining to mineral resources, the mining industry and trade in metals and minerals as well as their utilization gradually gravitated towards the Department of Commerce as a great clearing house. Before the transfer of the Bureau of Mines on July 1, 1925, the Interior Department probably had the most varied relations with the mineral industry in general and the petroleum branch in particular. It was likely for this reason that Secretary Work, in December, 1924, had been made chairman of the Oil Conservation Board. Today, through the Bureau of Mines, the Bureau of Standards and the Bureau of Foreign and Domestic Commerce, Mr. Hoover's department is able to help the operating oil industry and mining in general along more lines of real usefulness than any other Federal department.

Activities of the Minerals Division. This division of the Bureau of Foreign and Domestic Commerce was organized in July, 1924, to coordinate and make more effective the work carried on before by the Petroleum Di-

† See "Statistics of Income," edited by Edward White, November 1, 1926.

§ See "Government Waxed Fat from Investments of Oil Men," *The Oil and Gas Journal*, December 14, 1922; "State Control of Public Lands Deemed Unwise," *Christian Science Monitor*, September 20, 1926. Crude oil production from Federal lands increased from 42 million barrels (9 percent of the total) to nearly 90 million barrels (about 12 percent of the Nation's total) in 1925. Of the latter quantity, 12 million was derived from Naval reserves, 29.5 million from the Public Domain, and 48 million from Indian lands. Read opening address of Chairman Work of the Federal Oil Conservation Board, February, 1926, hearing attended by the author.

vision* and the Minerals Section of the Iron and Steel Division. Its functions include the collection and dissemination to Americans of information on foreign markets for petroleum and other mineral products, as well as data relating to foreign development and production of the various minerals and non-ferrous metals and to current surveys of foreign and domestic mineral, metal and petroleum activities. The Petroleum Section carries on the assistance rendered the American oil industry by the former Petroleum Division in the marketing of petroleum products abroad and in supplying facts about foreign petroleum development, production and legislation. As a result of one notice published in Commerce Reports† under "Trade Opportunities," one American oil company obtained an annual export business of \$250,000. Supplements to this weekly, known as "Trade Information Bulletins" are issued from time to time and deal with the petroleum trade and industry of a single foreign country. Thus "T. I. Bulletin No. 407" was entitled "British Petroleum Trade in 1925" and contained the usual Foreword by Julius Klein, Director of the Bureau of Foreign and Domestic Commerce.



BARTLESVILLE (OKLA.) PETROLEUM STATION OF THE BUREAU OF MINES

Its value to the oil industry is twofold—(1) The furnishing of technical information; (2) the training of men for executives, engineers and technologists. Among the many "graduates" from the research staff, now active in the industry, may be mentioned A. W. Ambrose, E. P. Campbell, F. A. Edson, H. C. George, H. H. Hill, J. O. Lewis, F. X. Schwarzenbeck, E. W. Wagy and L. D. Wyant. The superintendents have been successively, Messrs. Lewis, W. P. Dykema, Ambrose, Hill, T. E. Swigert, M. J. Kirwan, R. A. Cattett, W. W. Scott and E. P. Campbell whom N. A. C. Smith succeeded in April, 1926. For further details and view of the research staff see "The Oil and Gas Journal," January 6, 1927.

*This division was worked up in 1923 by Henry C. Morris who had served as confidential assistant to the Director of the Bureau of Mines during and after the War. See "Com. Bur. of Real Use to the Am. Oil Industry," by Chas. E. Kern in *The Oil and Gas Journal*, September 6, 1923; also issue to January 29, 1925: "Promoting Petroleum Trade Abroad," which refers to Guy C. Riddell as the first chief of the reorganized Mines Division. Since July 1, 1926, Homer S. Fox has been acting chief.

†One of the most helpful of all Government periodicals; issued weekly, 64 pages; subscription only \$4 through Superintendent of Documents, Washington, D. C.

Activities of the Bureau of Mines. Unquestionably, up to the time of the transfer of the public land mineral leasing unit to the Geological Survey, the Bureau of Mines had carried on the most comprehensive oil work. As indicated in the index as well as below, its duties are still vast and varied. It compiles and issues monthly statistics on crude oil production, storage and transportation, and apparent consumption in the United States; also on refinery operations. It publishes bulletins based upon its researches covering the entire field of petroleum, natural gas and oil shale technology in relation to production, transportation, refining, storage and chemistry. Its most signal service has pertained to the conservation of petroleum (page 40 and index) of which it has been relieved only in part by the Survey. Viewed broadly, the Bureau of Mines and the Bureau of Standards (page 101) together may be regarded as a great board of consulting engineers which furnishes free but expert advice and information on oil and other topics for the good of the Government, the industries, the present consumers, and the ordinarily ignored posterity.*

Contributions to the Conservation of Capital. The Bureau of Mines has not only prescribed and practiced immensely helpful measures for the conservation of both mined and unmined petroleum but it has experimented extensively in various ways to prevent vast financial losses. It has shown how the shutting off of corrosive waters in sands above the oil-bearing ones may not only lengthen the life of well equipment but will save the oil itself from salt water invasion. In Kansas alone the losses from underground corrosion in the producing fields are believed to exceed \$3,000,000 yearly.† In many fields the deposition of wax from the crude oil entering a well is a problem of major importance. In one Rocky Mountain pool the cost of removing paraffin from rods and tubing in 1924 was more than \$500,000. Laboratory studies indicate that removal methods cheaper and quicker than those in use are possible (see also index). The use of electrically driven equipment has been recommended for the reduction of costs, and the standardization of oil field equipment has been advocated in co-operation with the Bureau of Standards.

Committee Recommendations. Several changes in the Bureau of Mines work was recommended early in 1926 by Mr. Hoover's committee.‡ It stated that the work of the Petroleum Division has been helpful and of direct value to the oil industry. It has included: (1) The collection and

* For a summary of the annual report of the Bureau of Mines Director to the Secretary of the Interior covering the period before its separation therefrom, see *Oil and Gas Journal*, December 17, 1925. The present director is Scott Turner, experienced mining engineer.

† Bulletin 233, 1925, "Protection of Oil and Gas Field Equipment against Corrosion," by R. Van A. Mills; price, 35 cents; Superintendent of Documents, Washington. Among other very practical publications of the Bureau of Mines may be mentioned these other bulletins: No. 148, "Methods for Increasing Recovery from Oil Sands," J. O. Lewis, 1917; No. 163, "Method of Shutting Off Water in Oil and Gas Wells," F. B. Tough, 1918; No. 182, "Casing Troubles and Fishing Methods," Thos. Curtin, 1920; No. 192, "Carbon Black," R. O. Neal and G. St. J. Perrot, 1922; No. 194, "Principles Governing Production," Carl H. Beal and J. O. Lewis, 1921; No. 195, "Underground Conditions," A. W. Ambrose, 1921; No. 201, "Prospecting and Testing for Oil and Gas," R. E. Collom, 1922; No. 207, "Analytical Distillation," E. W. Dean, H. H. Hill, N. A. C. Smith and W. A. Jacobs, 1922; No. 210, "Oil Shale," M. J. Gavin, 1924; No. 234, "Manual for Oil and Gas Operations," T. E. Swigart and C. E. Beecher, 1923.

‡ This consisted of Messrs. H. Foster Bain, J. G. Bradley, D. M. Folsom, F. P. Hanaway, J. V. Reynders, C. P. White. See the *California Oil Bulletin*, April, 1926, p. 425.

publication of statistics; (2) investigation of operating methods within the industry with a view to the reduction of losses in the production, storage, and transportation of crude oil and petroleum products, and to the dissemination of data in regard to improvements in operating practice; (3) research work into the characteristics of oils and the treatment and utilization of products. It recommended that the collecting of statistics be transferred to the proposed economic branch of the Bureau and that the method of collecting and the form of publication of these statistics be carefully revised to make the figures of greater value to the industry. Suggestions were also made for the investigation of operating methods.

Contributions to the National Defense. An indirect aid in safeguarding our country has been through the conservation of the underground oil reserves by preventing water invasion, as already mentioned. Increasing the percentage of recovery obviously also promotes the national defense. During the war two particularly important accomplishments were credited to a Bureau of Mines man—the chemist, Col. George A. Burrell. These refer to research work in chemical warfare of which he had charge, 1917-1918, and to his discovery of a supply of helium in Texas. He initiated the Government helium program whereby this non-inflammable gas was extracted and finally used in dirigibles.† During the late war, Director Manning served on the National Cooperative Committee on Oil and the Bureau itself rendered great service in many ways other than those mentioned.

GEOLOGICAL SURVEY AND INTERIOR DEPARTMENT

Cosmopolitan Character of Interior Department. In former years new bureaus found their way into the Interior Department if they could not logically be allocated elsewhere. As a result, it became the most comprehensive and cosmopolitan of all the Government departments. Its rule ranged from Alabama to Alaska and from Florida to California. Its geologists and topographers climbed to the tops of ice-clad mountains and its engineers descended into the deepest mines. Its Bureau of Education encouraged reindeer raising in Alaska and taught the redskin various tricks. Through the Reclamation Service it drained the dismal swamps

† "The Linde Air Products Co. developed the successful process (of recovering helium from the natural gas in the Petrolia field). The Navy Department contracted with this company in 1919 for designing, building and operating the only helium producing plant in the world, located at Ft. Worth. In April, 1921, the initial cost of production was \$500 per 1,000 feet * * * since reduced to about \$50. * * *. The production on a commercial scale was forced on the Government * * *: (1) By military necessity; (2) in order to develop * * * processes by which helium can be obtained for a cost compatible with its use in commercial airships. The Government will later look to the great industries to carry on the work and permit it to return to its normal and rational pursuits. * * *. Helium is truly a by-product of the petroleum industry; but is not an asset or a liability? The Navy has demonstrated the practicability of helium-filled airships; the Government has developed processes for the recovery of helium; the Bureau of Aeronautics has developed a water-recovery apparatus which avoids the necessity for valving helium during flight; the Government has forced the design of cheap transportation—the helium tank car, without which the use of helium would be impracticable; American industries are established for the manufacture of all materials and equipment needed for constructing and equipping airships. * * *. From these facts, only one conclusion can be drawn—helium is an asset to the petroleum industry and one of no minor importance."—Rear Adm. W. A. MOFFETT, before the A. P. I. meeting at Ft. Worth, December 12, 1924. See *The Literary Digest*, April 29, 1922, pp. 52-53.

and watered the desert wastes, thus aiding and extending agriculture. Through the Geological Survey it likewise pioneered for petroleum and the mineral industry in general. Through the Land Office it lent aid to land seekers without interfering with the profitable retail trade of private realtors. Through the Patent Office it formerly promoted and protected the invention of devices and processes whether for reaping grain or for refining petroleum. In fact, it became so vast and varied that one of the world's greatest office buildings, erected especially for the Interior Department, did not quite suffice to house the horde of clerks and other help employed in Washington alone. This department is still quite complex and even after the loss of the Bureau of Mines, July 1, 1925, is able to offer a variety of superior petroleum services to the public and particularly to the operators. More than ever before is it now operated on a business basis under the progressive direction of Secretary Hubert Work.

Indian Office Important in Petroleum. The Office of Indian Affairs is charged with the protection of the health, wealth and happiness of the American Indian and his advancement to the competency of the average white man so that present restrictions may be removed and the privileges of full citizenship be conferred on him. The protection of his wealth alone is a tremendous task now that the possession of the dependent ones well exceeds \$1,500,000,000. At the close of 1923 the value of both individual and tribal property, including that of oil, gas, coal and other minerals, totaled \$1,011,000,000, a gain of \$283,000,000 over 1922. It was \$342,000,000 more than in 1913, the increase being largely due to the development of oil lands in the Osage country. In 1923, 54 million bbls., or one-third of Oklahoma's output, was derived from Indian lands. The revenue that year from oil and gas leases approximated \$37,000,000, of which over \$30,500,000

went to the Osages alone and nearly \$5,600,000 to the Five Civilized Tribes. Since then the Navajos of New Mexico have also participated in petroleum income following discoveries on the Hogback and Rattlesnake domes. In his administration, Comr. Chas. H. Burke is ably assisted by J. G. Wright, who long has superintended the Osage Agency at Pawhuska.*



THE DIRECTOR OF THE U. S. GEOLOGICAL SURVEY

Probably no other Government official has been longer or more consistently concerned with the conservation of petroleum than George Otis Smith, who has been on his job over 16 years, while directors of other bureaus have come and gone.

One of his most practical appeals to the oil industry was his able address, "A Producing Program for Profits," before the International Petroleum Congress, published in "The Oil Trade," November, 1924.

* See annual reports of the Commissioner of Indian Affairs; Marcossion's "Black Golconda," page 197; magazine section, *Washington Star*, August 31, 1924. "Navajo Leases Sell for \$4.72 an Acre," *Oil Trade*, November, 1923; "Sale of Ute and Navajo Leases," *Oil and Gas Journal*, June, 24, 1926.



—Rig and Reel Magazine.

HUNTING FOR OIL IN ESKIMO LAND, ALASKA

A typical scene on the tundra or the low Arctic coastal plain where Philip S. Smith and his associates of the Survey have been "mushing" on the Government's mission of locating new oil deposits for the future supply of the U. S. Navy.

Geological Survey's Search for Structures. The opulent Osages owe greatly to this Government organization their procural of liberal bonuses (up to \$14,200,000 at one auction, March 8, 1924) and their receipt of large royalties. Probably no equivalent petroleum area elsewhere in the world has been so completely covered with structural maps before the successive and final development of its various and numerous domes, anticlines and terrace structures as the 1,500,000 acres* of this leading oil county in Oklahoma. Most of the acreage on each structure was leased at the Pawhuska auctions only after the Geological Survey had initiated in 1917 its extensive field work in the Osage "nation," and in many cases had issued advance reports with maps and sections as guides to the prospective buyers in the event that they wished to avail themselves of such inexpensive but money-saving and money-making information and advice.† It was considered the most promising undeveloped territory at the time of our entry into the war and the investigations by the Survey were made in

* Almost the same as the total land and water area of Delaware, 2,370 square miles. This acreage was bought from the Cherokees by the Federal Government for the Osages at only 70 cents an acre.

† David White, chief geologist of the Survey for many years, lamented the lack of information, betrayed by the bidders in the size of the bonuses paid. "Although some had examinations made by geologists for their exclusive benefit, many tracts with favorable structures were neglected and large bonuses paid for others that may never yield oil in commercial quantities; * * * all the more unfortunate since later leases require drilling within nine months after approval date. * * * (In drilling unnecessary dry holes) the loss of the driller in bonuses, labor, equipment, supplies and transportation and even his loss of time and opportunity through fruitless boring in an area of distinctly unfavorable structure constitute an economic waste that affects the military efficiency of the Nation." See Bulletin 686, U. S. G. S., p. X; also *The Oil Weekly*, September 16, 1922.

response to the imperative need for increasing to the utmost our petroleum supply. K. C. Heald had immediate charge of this important work.‡

The Survey's Explorations in Alaska have been concentrated on Naval Petroleum Reserve No. 4 since this area of more than 35,000 square miles near Point Barrow was set aside early in 1923 by President Harding. Mapping of this northernmost part of the United States has involved four seasons of the most strenuous labors of many Survey men. They have traveled thousands of miles by dog team in the dead of winter and by canoe in the equally trying days of summer. During the summer of 1926 Dr. Philip S. Smith, chief Alaskan geologist, and G. FitzGerald, topographer, tried to complete the major problems of geography and geology in this polar desert where the annual rainfall is under 10 inches.*

Increasing Value of the Survey's Service. The work of the Geological Survey in connection with oil continues to increase in value. The application of geology to practical affairs is shown by the fact that in four oil fields extensively developed the early geologic mapping indicated the existence of oil in the ground. Many costly mistakes would not be made by beginners in the oil business if they would study the maps and reports, particularly the bulletins, issued by this constructive branch of the Government as results of its scientific investigations. The *direct* service of George Otis Smith, the director, and his highly trained staff of courageous and conscientious geologists, geographers and others can not be measured in terms of mere money. More appreciated by the industry is the *indirect* service of these men (and women) after their liberation from private work where a "living wage" is paid more in harmony with their worth.†

Public Land Relations and New Leasing Duties. The Survey has acted on more than 25,000 cases referred to it in the administration of public

‡ The big Burbank field was found six years ago by that strong believer in geological science, E. W. Marland, in the western part of Osage County where but little detailed work had so far been done. He paid \$12.50 an acre in May, 1920, for his lease on the discovery tract of 160 acres, and less than a year later only \$5 an acre was paid for two leases by others, one adjoining and another two miles away. In September, 1922, Gypsy (Gulf Oil) paid \$10,000 an acre, and in May, 1924, Cosden and Midland each paid almost \$12,500 an acre.

* From Nenana, on the Government railway in the heart of Alaska, they proceeded along the mail route, down Yukon River, and on for 600 miles to the town of Kotzebue on the Arctic Ocean. See Bulletin 783-E, U. S. G. S., 1926; press bulletin 6331, April 3, 1926; "Oil Developments in Alaska," in which, before the February, 1926, meeting of the Am. Inst. Min. Engrs., P. S. Smith stated that the entire output since 1904 was worth less than \$1,000,000, but that there are four fields in which petroleum has been found in seepages: (1) Yakataga, southwest of Mt. Elias; (2) Katalla on the coast in south central Alaska; (3) Alaskan Peninsula on west coast of Cook Inlet from Iniskin and Oil Bays southwest to Chignik; (4) northern Alaska now held as Naval P. R. No. 4. See also *The Rig and Reel Magazine* (of Parkersburg, W. Va.), May and June, 1924; "Hunting Eskimoland for Oil," by Guy E. Mitchell, U. S. G. S.

† "The foundation for the more general acceptance of the geologist by the oil industry, which prevails today, was largely laid by the series of intensive studies of known oil fields made in the early 1900's by the U. S. G. S. The reports on pools examined in Pennsylvania by R. W. Stone and F. G. Clapp; in Ohio by W. T. Griswold and M. J. Munn; in Coastal Texas and Louisiana by C. W. Hayes and Wm. Kennedy as well as by G. D. Harris and A. C. Veatch of the Louisiana Survey; and above all, California by Ralph Arnold, Robert Anderson, Harry Johnson and others, for the first time made available details covering a number of widely distributed pools. About 1907, many of the men who had made these early reports established themselves as consulting geologists and from this period until 1913-1914 geology won its way rapidly into the industry. Since 1914, the employment of geologists has been fairly general."—From "The Geologist and the Petroleum Industry," by E. DeGolyer, A. P. I., Ft. Worth, December, 1924.

lands. A few years ago the areas classified and reserved were as follows, in millions of acres: Coal, 65; petroleum, 65; oil shale, 4.1; phosphate, 2.7. Before the middle of 1925, it had been involved with the public domain only in an investigative and consulting capacity. At that time the Survey relieved the Bureau of Mines of its public land mineral leasing duties. To quote Director Smith: "Secretary Work's transfer of the mineral leasing supervision * * * permits a new line-up of the Interior Department's activities in promoting development of the public domain. The protection of the public estate, the guidance of the development of its resources, the promotion of wise use of the products therefrom are practical objects, all summed up in the one word, *conservation*. So it is that to the land classification activities of the Geological Survey are now added the supervision of the leasing of the oil, coal and other minerals, on the public and Indian lands. The two types of work are closely related and have had some informal connection in the past, but now they may be directly coordinated so that the oil geologist and the oil engineer, for example, will work in close contact on their common problem of wise administration of the resources in public ownership."

Oil Shale Work Foreshadows New Fuel Supplies. The development of our huge oil shale resources was arrested by the Drake discovery of petroleum in 1859. About 1910 interest in our Western shale-beds was renewed. * * * Our Government, realizing the rapid depletion of our oil resources, undertook to foster interest in and assemble data regarding our shale-beds. In 1913 the U. S. Geological Survey sent a body of field investigators to examine the colossal deposits in Colorado, Utah and Wyoming (page 120). Thus began the research that has been kept up in field and laboratory since that time. * * * In doing this work the Survey effectively illustrated one of the high functions of a federal government, namely, to play the rôle of pioneer and experimenter, foreseeing the social and economic needs of the nation, and *doing the necessary ground work of research in that important period before the incentive of immediate profit has begun to draw private investment and initiative into the field.** (On "Nationalization" see below and pages 243-5.)

STATE AND TREASURY DEPTS. AND INDEPENDENT BOARDS

The State Department Aids in Foreign Oil Development. It has been of indirect assistance to the American operators in connection with oil problems by insisting on the recognition of treaty rights and other guarantees, such as most-favored-nation clauses and mandate provisions. The Department of State has stood steadfastly for the principle of the "open door" or equal opportunity in the Dutch East Indies, Mesopotamia and Persia.† Under the able administration of Secretary Kellogg the Mexican Division of the Foreign Office is now preoccupied in protecting Amer-

* Abstracted from *The Century Magazine*, February, 1921, p. 542, "Defeating the Oil Famine." See also, "Oil Shale of the Rocky Mountain Region," Bulletin 729, by Dean E. Winchester, U. S. G. S., 1923; "Geol. Survey and Land Office Do Big Oil Business," *Oil Trade*, December, 1926.

† In an excellent article in *Mining and Metallurgy* for July, 1922, Attorney L. H. Woolsey outlines the limitations of the State Department and tells how it can be of further help in oil development abroad. See also address by Arthur N. Young, Ph. D., economic adviser of the Department of State, at the Institute of Politics, Williamstown, Mass., 1925.

ican oil properties in the Tampico region from ruthless confiscation and eventual nationalization as already effected by the Soviet Government.

The Treasury Department Collects Income Tax. Through the Bureau of Internal Revenue this department comes in close and extensive contact with the American oil industry. Within its Income Tax Unit ("I. T. U.") there gradually grew up the Natural Resources, now the Engineering Division,* devoted to the appraisal of mineral and timber producing properties and the auditing of tax cases concerned with natural resources. Of the engineering sections into which this Division became divided the most important since the war has been the Oil and Gas Section with which the author was identified during most of the 38 months in which he served as a valuation engineer. Valuations were generally based upon data supplied by the crude oil and gas producers for the determination of depletion allowances under the various revenue acts, also for the determination of profits or losses resulting from the sale of petroleum properties. At one time, from 1922 to 1923, over 50 valuation, assistant and associate engineers were employed on oil and gas cases, but very few of them in the field.

The Oil Relations of the I. C. C. The Interstate Commerce Commission, through the Bureau of Service, supervises pipeline and railway transportation of petroleum. There is hardly a mile of our 265,000 miles of main line track over which petroleum products do not move, chiefly by means of 153,000 tank cars. About 80,000 miles of pipeline are devoted exclusively to the moving of mineral oil. The carlot movement of petroleum and its products in 1925 aggregated over 1,951,000 carloads or 5½ percent of the total carload traffic originated that year in the United States. This exceeded by 55 percent the similar shipments of 1,258,000 carloads in 1920.†

The U. S. Shipping Board Once a Big Consumer. Since this body has been steadily disposing of its bottoms to private owners and operators of marine vessels, its consumption of fuel oil and other oil products has been declining. Of steel tankers alone it owned on June 30, 1926, 29 of 242, 663 deadweight tons after transferring 12 of 131,680 tons to Government departments and selling 109 of 1,073,150 tons. Of 8 concrete tankers it had lost 1, transferred 3 and sold 3.

GOVERNMENT NEEDS AND THE NAVY DEPARTMENT

Our Federal Government the Greatest Consumer. Departmental demands now aggregate 20 million barrels per annum. No single commer-

* Originally this was organized in 1918 as the Oil, Gas and Mines Section through the cooperation of Ralph Arnold, Carl Beal, Jas. L. Darnell, J. O. Lewis, G. B. Richardson and E. W. Shaw. The first head was Ralph Arnold, who was followed by J. L. Darnell. After the segregation of the Oil and Gas Section the chiefs thereof were as follows, in order of succession: Frank Herald, C. F. Powell, Norval White, Russell Beall, S. M. Greenidge and W. N. Thayer. The present head of the entire Engineering Division is Andrew Walz; assistant head is Samuel Hatchett. Chief of the Oil and Gas Section is Geo. W. Campbell assisted by Percy L. Ports as reviewer and Wm. G. Cullen, who are probably the oldest valuation engineers in point of continuous service. Stanley Sears is now chief of the Mining Section, E. L. Lindsay of the Timber Section, Frank Eddingfield of the Appeals Section, and J. M. Clark of the Appraisal Section. J. C. Dick, of Utah, was head of Natural Resources when the author entered the I. T. U. in May, 1920. His successor was C. F. Powell, who was followed by Albert H. Fay and S. M. Greenidge.

† Abstracted from address of Director Wm. P. Bartel before the A. P. I., Tulsa, December, 1926. See *The Oil and Gas Journal*, December 9, page 88.

cial consumer of petroleum compares with Uncle Sam in this respect. This quantity is almost half as great as that required by all the oil burning locomotives on the American railways (page 96). Louisiana, the seventh state in oil, alone barely supplies as much. The entire output of Ohio, Pennsylvania and West Virginia together in 1926 would have to be taken to fill the bill in crude equivalent. Naturally the Navy needs more petroleum products than any other department, although it still consumes considerable coal—about one-third million tons, costing annually about \$2,-800,000. The demands of the Department of Justice is likely the least of any. Army trucks and postal airplanes require both gasoline and lubricants. The Treasury Department, through the Supervising Architect, must see that all the Federal buildings throughout the country are kept warm in winter time. The Government, however, does not look favorably upon the use of oil for heating where coal is available.*

The Navy's Increasing Call for Liquid Fuel. Coal is not altogether in disfavor, for in some places or for some purposes it is preferred because of local economy or peculiar requirements. About 340,000 tons measure the annual demand of the Navy for solid fuel at a cost of about \$2,800,000. About 7,350,000 gauges the peace-time need of the Navy for liquid fuel including fuel oil (7,000,000 bbls.), gasoline (190,000 bbls.), Diesel oil (110,000 bbls.), and lubricating oils (50,000 bbls.). In time of war this consumption would immediately increase to four or five times the above stated quantities, depending upon the theater of action.†

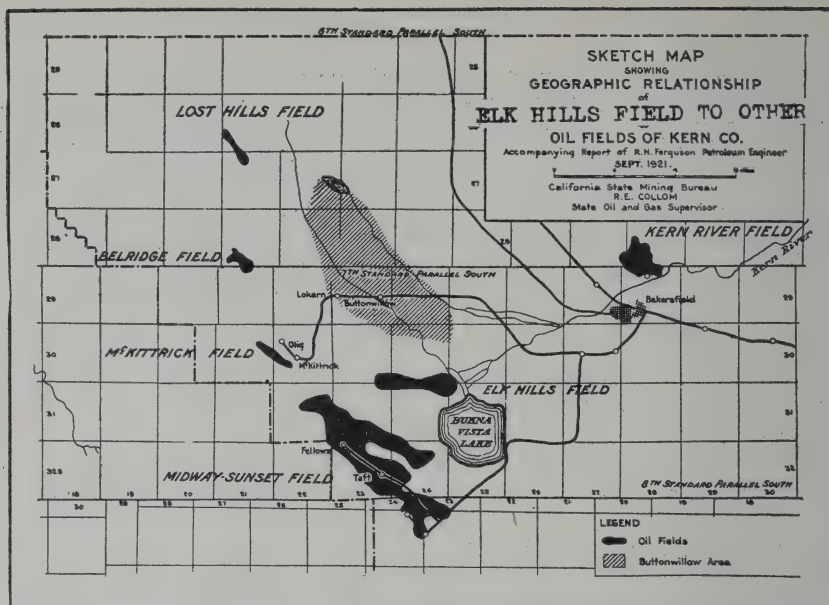
Buying and Storing Petroleum Supplies. These products are purchased usually under annual contracts for delivery at the various ports within the United States most convenient for the use intended. Bids are invited according to advertised specifications. For the storage of these products the Navy has constructed at a number of naval stations and fuel depots the usual type of containers known to the commercial oil world. The total capacity for fuel oil storage is 7,244,000 bbls., 3.4 times what it was six years ago. The more important storage points are at Pearl Harbor, Hawaii; Yorktown, Va.; Portsmouth, N. H.; Guantanamo, Cuba; Puget Sound, Wash.; Melville, R. I.; Balboa and Cristobal, Canal Zone; Cavite, P. I.; Hampton Roads, Va.; San Diego, Calif. Additional stocks are at Boston, Key West, Charleston and Norfolk. Only a few of these are distributing points for naval Diesel oil, but many of them carry gasoline supplies for trucks, launches and hydroplanes.

* Post offices and custom houses on the Pacific Coast are occasionally heated on a small scale, using fuel oil to generate the steam heat. The author recalls receiving bids for such oil of about 18 degrees B., early in 1911, while he was acting as custodian of the Federal building in Los Angeles. The District of Columbia is reasonably close to coal fields; but both economy and convenience dictated the construction of a central oil burning plant about two years ago. See "Government to Heat Buildings with Oil," by

† *Production from Government lands during the five years before 1926 was as follows, in thousands of barrels, according to the Oil Conservation Board:*

Sources	1921	1922	1923	1924	1925
Crude from Naval Reserves.....	2,154	7,205	11,427	13,032	12,371
Crude from Public Domain.....	9,215	20,997	36,574	12,647	17,226
Total crude petroleum.....	11,369	28,202	48,001	25,679	29,597

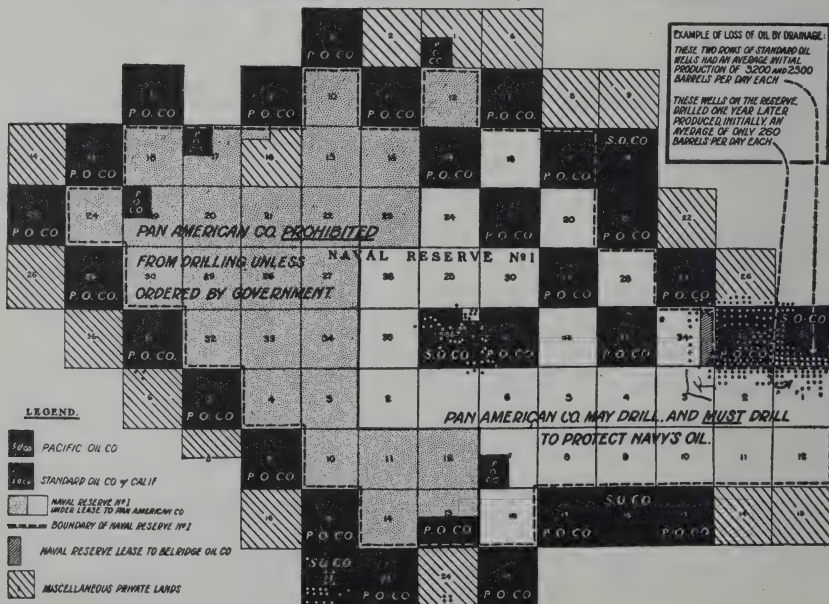
Output from Indian lands under Government supervision exceeded 596,795,000 bbls. of oil during the 26 fiscal years 1899-1924, and approximated 48,486,000 bbls. during the year ended June 30, 1925.



THE DOHENY LEASE (Pan American Co.)

MAP OF ELK HILLS NAVAL RESERVE No. 1. (California)

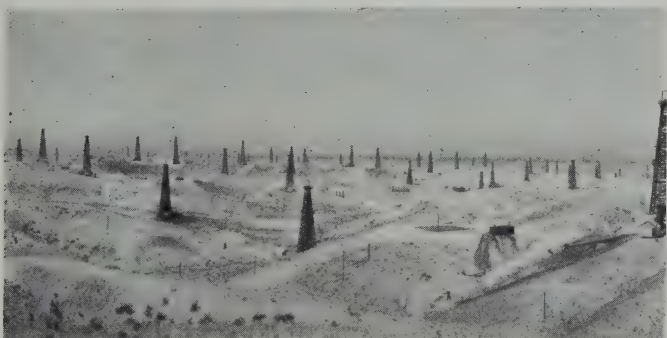
Showing situation of lands owned by producing oil companies within and adjoining the Reserve, which drained and threatened further drainage of the Reserve, and made leasing necessary, to save the Navy's oil for the Navy.



Unknown Underground Reserves. As a source of supply for the future and for emergencies, there have been set aside certain areas of public lands as Naval Petroleum Reserves, following field work by the Geological Survey.

Reserve	Acres	Location	Reserve	Acres	Location
No. 1	31,892	Kern Co., Calif.	No. 4	22,400,000	Pt. Barrow, Alaska
No. 2	10,417	Kern Co., Calif.	Shale No. 1 .	36,550	Garfield Co., Colo.
No. 3	9,321	Natrona Co., Wyo.	Shale No. 2 .	86,584	Uinta Co., Utah

Reserve No. 1 is under lease almost in its entirety to the Pan-American Petroleum Co. The Government brought suit for the revocation of this lease, winning in the lower courts. Appeal to the Supreme Court was to have been heard as this book was in press, late in 1926. Reserve No. 2 is under lease to various oil companies under sliding-scale royalties up to 30 percent or more. Owing to the fact that Pacific Oil Co. (now part of the new Standard Oil of California) is the owner of alternate sections within this reserve, its use as a source of future supply is of little value. The average monthly royalty received by the Navy from these two reserves approximates 225,000 bbls. Measured in money (a secondary consideration) at \$1.30 a barrel this would mean an annual income of \$3,510,000.



—The Lamp.

SCENE IN THE DEVELOPED PART OF THE ELK HILLS DISTRICT, CALIFORNIA

This district (in Kern County which has produced almost as much oil as Mexico) contains Naval Reserves No. 1 and No. 2 of 31,892 and 10,417 acres, respectively. Elk Hills became a large producer in 1920 after some completions were made in 1919. It is still largely undeveloped although yielding at the rate of 35,000 barrels daily in June, 1926. Among fields in the San Joaquin Valley it now ranks next to the immense Midway-Sunset.

Reserve No. 3 was under lease to the Mammoth Oil Co., a Sinclair subsidiary. The lease was invalidated on September 28, 1926, by the U. S. Circuit Court of Appeals and the defendant ordered to make restitution of the oil removed. It had been yielding a monthly royalty of only 5,000 bbls. Reserve No. 4, as elsewhere related, lies within the Arctic Circle in Alaska. Its inaccessibility makes it of doubtful value even if oil in large quantities be discovered.

CONSERVATION WORK ACCOMPLISHED AND REQUIRED

Wide Field for Conservation Work. In recent years public-land legislation has sought to promote the best utilization of the water power, the conservation of flood water, reserving of coal land from agricultural entry, and the protection of the oil industry from itself, by discouraging pro-

duction in advance of possible needs. All these efforts towards wiser use of the great natural resources of the West were made by the Federal Government in its capacity as the largest landowner. The protection of the public estate, the guidance of the development of its resources, the promotion of the best use of the products from the national domain are practical objects, all summed up in the one word *conservation*.

World's Richest Owner of Fuel and Phosphate Reserves. The United States owns about 30 million acres of coal lands with valuable coal deposits of over 200 billion tons. It has one-half million acres of phosphate lands which can supply 8 billion tons of this essential fertilizer when needed for American farms. There are 4 million acres of oil shale in the public domain from which possibly 60 billion barrels of oil can be extracted when prices warrant the higher cost of its development. Before that time, however, there are millions of barrels yet to come from wells on Government lands, the amount now being taken from public and Indian lands, representing one-tenth of the nation's annual petroleum production (about 75 million barrels in 1924, or more than the entire country produced in 1900).

Essentials for Safeguarding This Vast Estate. To protect this for future generations and permit its economic development to supply present needs requires foresight and administrative skill. Five years ago Congress enacted the general leasing law which established the system of leasing mineral deposits on public lands to private operators, the Government to receive bonuses and rentals as well as royalties. There are now (December 1, 1925) outstanding 211 leases on Government coal lands and 422 on oil and gas lands. To supply this policy a new line-up of mineral leasing activities was affected in the Interior Department through the organization of a conservation branch in the Geological Survey. In this enlarged unit were placed geologists and engineers designated to act as technical advisors and administrators in the classification of the public lands. In addition, their duties consist of inspecting mine operations and cooperating with the private operators to avoid waste in the production of minerals on the public domain.

Oil and Gas Leasing Work Was Reorganized in the Conservation Branch. Three field divisions (California, Mid-Continent and Rocky Mountains) were established under jurisdiction of district supervisors or engineers in charge. They were given full authority and responsibility to conduct operations and represent the Government in problems necessitating immediate decision not involving departmental policy, in place of the old practice of referring all questions of administration to the Washington headquarters. * * * A feature stressed by the Geological Survey is the scientific examination of mineral areas of the public domain to promote and guide development. * * * With the creation of this new unit it is believed that the custodial care of our natural wealth of oil and gas, coal and other minerals has been placed on a practical administrative basis. Engineering efficiency, avoidance of waste, and the wide use of these resources are now being practiced and future public interests are being protected.*

* These three preceding paragraphs have been extracted from Secretary Work's recent review of advance in conservation of natural resources.

Conservation of Private Deposits not Controlled. Uncle Sam is helpless to prevent waste of oil and gas in their production from privately owned properties. He can only educate and advise if consulted. Since neither Congress nor the executive offices of the Federal Government have power under the Constitution to control such productions or to regulate the same, the only available remedy lies in judicious state legislation. State laws alone can prohibit the blowing of gas into the air in order to get through to the underlying oil.†



THE ORIGINAL OIL CONSERVATION BOARD AND ITS SECRETARY

Designated by President Coolidge, December 19, 1924. Since then the late Mr. Weeks (at extreme left) was succeeded by Dwight F. Davis (see page 130). General Counsel (not in photograph) is Charles W. Waterman; Secretary, Edward S. Rochester. Technical and Advisory Committee—George Otis Smith, Maj.-Gen. Edgar Jadwin, Rear Adm. H. H. Rousseau, and Harry H. Hill.

THE FEDERAL OIL CONSERVATION BOARD, 1925-1926

Purpose of Appointing the Board. It was created Dec. 19, 1924, by President Coolidge, not to serve as a salve or sinecure for "lame ducks" but to utilize established Government machinery in an earnest effort to accomplish four more or less related objects: (1) To coordinate and strengthen the current conservation work of the Federal bureaus; (2) to find all facts that might shed broader and better light on the needs and means for both public and private saving of natural resources in oil and gas as well as their ultimate products; (3) to invite and invigorate complete and sound cooperation with the oil industry itself, and (4) to disseminate the results of its investigations so that the millions of American consumers may do their share to avoid waste of the very products which at any time may be indispensable for the National Defense.

Part of the President's Letter Creating the Board. "It is evident that the present methods of capturing our oil deposits is wasteful to an alarming degree in that it becomes impossible to conserve oil in the ground under our present leasing and royalty practices if a neighboring owner or lessee desires to gain possession of his deposits. Developing aircrafts indicate that our

† E. B. Reeser, vice-president, Barnsdall Corp., quoted in *Nat'l Petroleum News*, December 2, 1925. See also "A Big Step toward Conservation," in which W. C. Teagle told the Federal Oil Board how fuel oil and the new cracking process influence petroleum economics; reprinted in leading periodicals and abstracted herein on page 268.

national defense must be supplemented, if not dominated, by aviation. It is even probable that the supremacy of nations may be determined by the possession of available petroleum and its products. I am advised that our current oil supply is kept up only by drilling many thousands of new wells each year, and that the failure to bring in producing wells for a two-year period, would slow down the wheels of industry and bring about serious industrial depression. The problem of a future shortage in fuel and lubricating oil, not to mention gasoline, must be avoided, or our manufacturing productivity will be curtailed to an extent not easily calculated. We are not today, however, facing an under supply of oil. The production of our 300,000 wells is in excess of our immediate requirements. That overproduction in itself encourages cheapness, which in turn leads to wastefulness and disregard of essential values. Oil, of which our resources are limited, is largely taking the place of coal, the supply of which seems to be unlimited, but coal can not take the place of oil in most of its higher uses, on land or sea or in the air."

Unostentatious but Effective "Modus Operandi." The Secretaries of Commerce, War, Navy and Interior organized themselves early in 1925 and lost no time in tackling their big job, aided by an able Secretary in the form of an experienced publicist, E. S. Rochester. Work was prosecuted principally along three lines: (1) Conferences between themselves and their consultants in the different departments; (2) questionnaires sent to producers, refiners, marketers, engineers, geologists and economists as well as others competent to furnish facts or to express opinions of value; (3) semi-public hearings which marked momentous progress in cooperation and understanding between Government and Industry. The hearing held in February was a noteworthy one, in that never before, to the writer's knowledge, had such a spirit of good-fellowship been shown at any similar meeting. On this occasion there gathered together the ablest representatives of the oil business and of the Federal Government which included Cabinet members and petroleum experts.

Oildom's Answer Anticipated Inquiries. In August, 1925, the A. P. I. Committee of Eleven, for the purpose of allaying public fear as to failing supplies of petroleum, presented in book form a very fine report on "Supply and Demand."* There were 13 instead of 14 points in the Summary of Conclusions: (1) No imminent danger of exhaustion of our petroleum reserves; (2) a sufficient supply of oil will be available for National defense and for essential uses beyond the time when science will limit the demand by developing more efficient use of or substitutes for oil, or will displace its use as a source of energy by harnessing (an other) natural energy; (3) current supply and demand (see Chapter XIII) can not stay in balance, since the amounts of both are constantly changing; (4) petroleum recoverable by present methods of flowing and pumping from existing wells and acreage thus proven is estimated to consist of 5,300,000,000 bbls. of crude oil; (5) thereafter there will remain in areas now producing and proved 26,000,000,000 bbls., a large part of which can be recovered by improved and known processes such as flooding, air and gas pressure, and

* Although this committee consisted of leading lights in Oildom and its report was rather comprehensive because it was not confined to petroleum but included oil shales and coals as future sources of supply, it was subjected to severe criticisms from members of the Institute. See p. 142 *The Oil and Gas Journal*, November 5, 1925; also *Oil Bulletin*, September and *The Oil Weekly*, August 21, 1925.

mining, when price justifies; (6) deeper drilling will disclose deposits hitherto unavailable in producing fields—tantamount to the discovery of new fields—and through more perfect production methods the deep oil may be recovered; (7) the major U. S. reserves lie in about 1,100,000,000† acres of land underlain by sedimentaries in which geology shows oil possibilities; (8) additional reserves appear in the vast deposits of oil shale, coal and lignite, from which liquid fuel and lubricants may be extracted if, and when, the recovery cost is justified by prices; (9) Latin America has large petroleum resources for the output from which the United States is a natural market and the supply therefrom must inevitably influence the drain on our reserves; (10) availability of future petroleum supplies from the vast area above mentioned depends upon *adequate* incentives to the exploration which has so far supplied all the nation's needs for oil in peace and in war*; (11) more efficient utilization will lengthen the supplies, as, for instance by doubling or trebling the motor car mileage per gallon of gasoline; (12) through improved methods, principally the cracking process, the refining branch has already increased the yield of gasoline, now the major product of petroleum, and in consequence of the draft on fuel oil for additional cracking this former main product may eventually be removed from (the cheapening) competition with coal (see pages 95-99); (13) (wilful?) waste in the production, transportation, refining and distribution of petroleum and its products is negligible.

A Scientist's Sidelight on Our Future Oil Reserves. In *Mining and Metallurgy* for April, 1925, appeared the results of an independent study of this subject,‡ the summary of which follows: (1) Our reserves are being rapidly depleted; (2) our consumption is steadily mounting; (3) substitutes for gasoline are known to be insufficient to meet the situation; (4) our ownership in foreign oil is limited; (5) stability of prices and certainty of supply cannot be assured with imported oils; (6) the threatened depletion of our reserves entailing the passing of the United States from the position of supremacy in the world's natural petroleum production, shows the wisdom of Great Britain's support of her nationals in the acquisition of potential oil reserves throughout the world. President Coolidge wisely grasping the situation, appointed a Federal Commission to study the petroleum problem confronting the nation. This Commission is receiving cooperation from the entire industry and its findings will be looked upon with the utmost respect. It is asking the oil industry to propose the remedies to prevent waste and to work out ways to obtain the highest possible degree of efficiency of such oils as we have.

† Some authorities discount this high estimate since explorations over a long time and wide expanse within some of the states included entirely have resulted in little or no yield.

* There must be: (a) Security in the ownership of oil lands and of the right to lease; (b) conditions of exploration and development by owners or lessees allowing exercise of initiative, liberty of action, play of competition, and free working of the supply and demand law; (c) prices that will give a return to producers, refiners and distributors commensurate with the risks and capital involved. The McGraw-Hill Book Co., 370 7th Ave., New York, published "Supply and Demand"; price, \$3.00.

‡ By Cassius A. Fisher, consulting geologist and fuel engineer, Denver, Colo.; with the U. S. G. S. and Bureau of Mines, 1896-1912; U. S. Naval fuel exploration, Alaska; co-author with Ralph Arnold and Jas. L. Darnell of the original "Manual for the Oil and Gas Industry," which was revised by the author and others in 1921 for the Bureau of Internal Revenue. See also "Checking Up on Our Fuel Wastes," by Floyd W. Parsons in *Nation's Business*, February, 1926; "Plenty of Oil in Sight?" by J. O. Lewis in *The Compressed Air Magazine*; abstract in *The Literary Digest*, September 4, 1926.

THE FEDERAL OIL BOARD'S FIRST REPORT *

Concise and Comprehensive was this timely report tendered President Coolidge, September 6, 1926. A preliminary statement pertained to the present status of the oil industry which transports the crude from 300,000 wells through 90,000 miles of trunk and gathering lines, 400 tank steamships and many † tank cars to some 500 refineries. The industry has about \$10,000,000,000 invested in producing wells, transportation, refining and marketing equipment. Under "Distribution of Use" it was shown that in 1925 the crude petroleum produced was split by refinement into 49.3 percent gas and fuel oil, 23.4 percent straight-run gasoline, 9.1 percent cracked gasoline, 8.1 percent kerosene and 4.2 percent lubricants. Other topics taken up were "Known Fields," "Possible New Fields," "Improved Methods of Recovery," "Better Control of Production," "Better Utilization of Crude," "Better Mechanical Devices," "Foreign Sources," "Supplies from Oil Shale and Coal," "Reinforcement of Supply," "Control of Flush Flow," "The Right of the State," "Aid to Engineers," "Voluntary Agreement of Owners," "No Monopolistic Control," "Government's Own Problem," "Production from Indian Lands," "Legislative Remedy for Osage Leasing Evils," "National Defense Requirements," "Naval Storage Reserves," "Continuation of Inquiry," "Cooperation of States," and "Cooperation Within the Industry." Some of these subjects are considered below.‡

Sources of Future Supply: (1) Reserves of about 4,500,000,000 bbls. available by flowing and pumping from more than 3,000,000 acres of proved and producing oil land; (2) possible discovery of new sands in known areas by deeper drilling (as actually occurred at Spindle Top, summer of 1926); (3) possible discovery of new fields (such as the Seminole, Okla., July 16, 1926); (4) improved methods which will recover a larger proportion of the oil out of the sands; (5) better utilization of crude oils

* **Chairman Work's Significant Prelude.** "This first report presents certain facts contributed by the oil industry or gathered by Government scientists. Facts and opinions received from these sources have been weighed with open minds, without conscious prejudice or thought of confirming theories preconceived. There are two sides to this nationally important question * * * ; each has its proponents, and both sides are entitled to respectful consideration. (1) Many producers claim that the supply of petroleum, hitherto equal to the demand, probably always will be and, should time prove the contrary, that substitutes for both lubricants and gasoline will be devised. (2) Other producers argue that almost every natural resource is limited and may be exhausted by wasteful use. They cite depletion of soil fertility, timber, and even fish in the sea, the exhaustion of old oil fields and the diminishing flow of all wells. They argue further that without discovery of new fields the present rate of output can not be maintained, and therefore urge that, as new discoveries are uncertain, improved methods of recovery, less waste, more ground storage, and checking of competitive haste in drilling are economic provisions that should be enforced. These conflicting opinions are based partly on facts and partly on conjecture. Such opinions are valuable only in proportion to the logic of their reasons, which therefore must be understood and analyzed. It is hoped that this first report, conscientiously prepared under the direction of this board by scientific men burdened with exacting daily routine duties, may furnish a concise picture of the true conditions * * *."

† 142,000 tank cars altogether; used more for distributing refined products than for carrying crude oil.

‡ Abstracts of the report have appeared in all periodicals on petroleum including *Nat'l Petroleum News*, *Oil Trade*, *The Oil Weekly* and *Petroleum World*. For the most complete reproduction of the report see C. E. Kern's article in *The Oil and Gas Journal*, September 9, 1926. *The Outlook* for September 15, 1926, editorially reviewed the report on page 72. The complete report is sold by the Superintendent of Documents for 10 cents.

by diversion from less to more essential uses—such as conversion of fuel oil into gasoline; (6) better control of the flush flow from newly discovered fields; (7) economies in consumption by improved mechanical devices; (8) supplies from distillation of oil shales and coal; (9) foreign oil fields.

Proven or Known Oil Fields. In addition to the proven reserves at any one time, the known fields have in many cases proved of larger extent than at first estimated, due to the extension of the "fringes" of such fields. Particularly is this the result of opening new sands and in some instances the extension of known sands by deeper drilling. There have been great advances in the art of deeper drilling during the past few years. The first successful well drilled—in 1859—was to a depth of 69 feet. The capacity of machinery for deeper work was steadily developed until, in 1925, an oil well 7,591 feet was completed in southern California.* At various stages in development it has usually been asserted that no greater depths could physically be attained, yet almost every year demonstrates the penetration to still lower levels. As many of the sands slope into the earth, deeper drilling of known sands will bring still further production as well as the discovery of deeper sands underneath those now being exploited.

Possible New Fields. Certain parts of the country are known by their geology to be impossible of appreciable oil production. Such positively barren areas are estimated to aggregate 43 percent of the total of the United States. But this does not warrant the assumption that the remaining 1,100,000,000 acres of the country, or any large part of them, will be found oil bearing. Considerable portions thereof have already been drilled for oil or water. It is a certainty that we are learning each year more of geologic structure at the hands of * * * geologists, but the percentage of dry holes in new exploration is increasing. To assert that no new fields will be found would be to deny a very strong law of probabilities. We may conclude that such fields will be found, but obviously no forecast of their importance can be given.

Improved Methods of Recovery. Estimates of the amount of oil left underground vary widely. Oil experts generally believe that no more than 25 percent of the oil can be recovered by ordinary methods. Some authorities consider it to be less than one-sixth. During recent years, considerable investigation and experimentation has been made with different methods of forcing out the contained oil with water, air, or gas pressure—either directly from the surface or through the proposed method of sinking shafts and driving galleries. Authorities on these methods believe that thereby a second crop from known sands can be obtained as great as that already recovered. * * * Such a result would add a total of over 13 billion barrels to our supply from known fields. It is the impression that developments have proceeded so far as to give firm belief in much further recovery from the known sands over and above the issued estimates as to the supplies available through present methods.

Better Control of Production. There are subsidiary phases of overproduction which deserve attention, as they lead to economic waste. At the initial opening of new fields the gas pressure is strong and the flush flow of wells is very large, rapidly diminishing to more settled produc-

* Only a few weeks after the Oil Board made its report the world's depth record was broken again in that state in the Brea-Olinda or Fullerton Field near Los Angeles. An electrically driven rotary bored to 8,046 feet by October 1, 1926.

tion, and the opening of new fields is in most instances followed by a fever of drilling. Due too often to divided ownership in small areas, the drainage of which is threatened by adjacent wells, a rush of drilling leads to enormous flush flows which temporarily glut the market (pages 76-78) and force much oil into fuel consumption, and, through over-release of the gas, diminish the amount of oil that can be ultimately obtained by flow and pumping.*

Not a Monopolistic Menace. The voluntary cooperation proposed (namely *unit development and production*) should include the landowners and operators in a single field or pool (a relatively small unit of production), so that the possibility of monopolistic control need not be feared. Indeed, cooperative regulation of either the development or the operation of a single pool could control but a small percentage of the country's production. The largest† flush pool in recent years—Santa Fe Springs in California—contributed 11 percent to the output in 1923, and no pool contributed more than 8 percent to the output of either 1924 or 1925. Indeed, the three exceptional pools during 1925—Smackover, Long Beach, and Tonkawa—together accounted for only 16 percent of the country's production. Even the flood from the Cushing field at the time of its maximum yield in 1914 and 1915 is to be credited with only 17 percent of the nation's output in those years when the total yield was but a third of that of 1925.

Instance of Cooperative Control. The Salt Creek Conservation Committee prorated production in 1922 and 1923, reducing the output to perhaps one-third of the capacity of the 600 to 700 wells then producing. The effect of the committee's restrictions was a matter of only 8 or 9 percent of the country's production during that period. The question of the country-wide influence of such cooperative action on either supply or price would, moreover, under any legalized procedure, be always subject to "ap-

* **Control of Flush Flow.** The common right of adjoining owners to reduce to possession respective oil and gas in the pools tapped by wells drilled on their lands should involve some recognition of correlated obligations, so that in the drawing of oil and gas by one owner from the common reservoir the producer should recognize the right of the neighbor to so much of the oil as is withdrawn from underneath his property, less a reasonable allowance for the cost of production, the hazard of the undertaking, and a reasonable profit thereon. The right of the State under its police powers to prevent the action of one owner from depriving other owners of a common property, and to prevent waste or destruction of the common property by one of the owners, seems reasonably clear.

The right of the State to prevent the waste of natural resources is rendered more important in this matter by the newly discovered role of gas in the oil sands. Gas is more than a commodity of smaller commercial value associated with the oil; it is the efficient agent provided by nature for bringing the oil within the reach of man. Dissolved in the oil, the gas makes the oil flow more freely to the well and there forces it upwards. The longer the gas is retained in solution the larger is the recovery of oil. Waste of gas is therefore a double waste, and the impairment of the gas pressure * * * by one owner may prevent neighbors from recovering any of the oil beneath their land * * *. The authority of the State to prevent the waste of natural gas * * * applies as well to the dissipation of gas pressure without which great quantities of oil would be entirely wasted. Geologic science and engineering practice as well as economic considerations of waste afford a broad foundation on which to base State legislation. If the several oil-producing States should protect property rights in oil produced from a common underground supply, it undoubtedly would have some effect in the direction of stabilizing production, of retarding development whenever economic demand does not warrant, and of *making the business of oil production more economical.* * * *

† Considering a year's yield and not the maximum daily production for which Smackover with about 430,000 bbls. daily in a week of May, 1925, holds the record (Author's note).

propriate and adequate governmental scrutiny," quoting from counsel of the American Petroleum Institute, "to the end that these owners might not be stimulated to undue haste and wasteful competition in the development of their properties and trade, but might have a greater liberty to consult the economic conditions of the industry from time to time."†

EXTRACTS FROM ADDRESSES DELIVERED AT THE HEARING OF THE OIL BOARD, FEBRUARY 10-11, 1926

George S. Davison, President Gulf Refining Co.: Disregarding the wastes of former years, * * * for the year 1925 full 98 percent of the crude was transformed into salable products, though a part of this was as a matter of economy used in the refineries as fuel in place of coal. * * * Unless restricted by law, the refiner is likely to work up his crude petroleum into products which will bring him the largest net return, with the exception that it is generally found necessary to supply customers with some products at a loss in order to maintain their patronage for other products in which there is a profit. * * * There have been many changes in marketing practices. These have been caused by the severe competition among the factors in the industry. This same cause will doubtless lead to further changes in the future. Just as those changes which have been made have had the effect to better the service and lessen the price to the consumer, it is fair to assume that the future changes will

† **Other Cases of Noncompetitive Control.** (1) For a decade, the Cabin Creek Field in West Virginia has been an outstanding example of an economical drilling program having a definite purpose of high recovery at low cost and at a rate adjusted to demand. The field is owned by a single company (Pure Oil) and has been operated as a unit with the definite purpose of meeting only the requirements of the company's refinery and that for the longest possible time at the least possible expense. This two-fold aim * * * was sought through planning the economic spacing of wells and through conserving the gas pressure in the oil-bearing sand. Freedom from the pressure of competition has made possible at Cabin Creek a remarkably controlled production curve for the field, bearing little resemblance to the decline curves of other fields. Thus the output from this field was the same last year as eight years before. (2) Another example of an oil pool favored with noncompetitive control is Rainbow Bend, in Cowley County, Kansas, where three large companies owned only undivided interests in the surface over the pool. This was discovered at a time of overproduction (in 1923), but in spite of transportation facilities permitting rapid development, wells were put down cautiously, * * * dry holes reduced to a minimum, gas was not permitted to escape and reduce pressure, storage requirement was kept down—all factors making for economy. Such a pool, though small, acts as a desirable reserve slowly drawn upon, since it did not reach its peak of production until 19½ months, as compared with 1½ months for the larger and more spectacular Wortham, Tex., pool, where the control was divided into 91 competitive blocks. It was significant that the price of crude began to rise just after the crest of the Wortham flood of oil passed, and Rainbow Bend slowly attained its maximum output while the price was at its best. (3) The Reagan County, Tex., field, a somewhat more productive pool, was controlled by two companies (Marland Oil being one), which cooperated rather than competed, with resulting conservative rates of development, spacing of wells, and holding back production during times of greatest overproduction. The decline in Reagan County pool had not begun 2½ years after its discovery. It serves in a way as a reserve to be drawn on when its output is needed and the price compensates the owners. Under such conditions supply is responsive to control. (As illustrating the lack of cooperative control the Board refers to the Santa Fe Springs Field, which is considered in Chapter XIII, under "Financial Losses and Conservation.") Strangely conditions abroad favor conservative development and more complete recovery of underground oil than in the United States. Mexican examples include the Alamo pool, of the Penn.-Mex. Fuel Co., and the Casiano pool, of the Mexican Petroleum Co.

also accomplish the same purpose, but I can not see that these changes in marketing practices will tend to accomplish the result of conservation which the commission is considering.

Amos L. Beaty, Chairman of the Board, The Texas Co.: Nine-tenths of the country's petroleum production, being drawn from privately owned or State lands, the same proportion would seem subject to State laws of conservation. * * * It is true only to the extent that State conservation laws are permissible under the Federal Constitution; for property rights flowing even from the State itself are protected by the Federal Constitution. * * * Should the States legislate the uses to which a particular product, privately owned, shall or shall not be put? Assuming, but not conceding, that the State could enforce an act forbidding the burning of residual oil under boilers, should the State undertake such a thing? I submit that it is infinitely better to allow economic laws their play. It would be scarcely a step from a legislated use to a legislated price. * * * If fuel-oil were withdrawn from the smoke-stack market it would be cracked into gasoline. Oversupply and resulting cheapness lead to waste, no less in gasoline consumption than in that of other products. One outstanding result would be the placement of a handicap upon railroads and industries now burning oil and the building up of motor-bus lines and other unnecessary competition. The natural trend is strong enough and should not be stimulated by legislation. * * * The legislatures of the oil-producing States have enacted laws touching many of the subjects * * *. These enactments are varied and far from uniform. * * * Public sentiment varies still more. * * * It is not easy to obtain legislation for the benefit of an industry. * * * Legislators are often jealous of State sovereignty and independence, * * * seldom willing to follow advice from industrial leaders. They listen, obtain a smattering of the subject, then feel prepared to change bills submitted. * * * Year after year, in State after State, those conducting business on a nationwide scale find it necessary to attend hearings and go into arguments on matters fundamental and known to business men * * * in order to prevent serious injury through foolish laws. * * * Not many of the States are interested as much in conservation of oil as they are in its development. States that produce none are anxious to become producers. Those producing little are anxious to produce more; to them no argument favoring conservation would have a strong appeal. I seriously doubt if the great oil-producing States of California, Oklahoma and Texas * * * would listen to a plea to hold back production for future generations, * * * especially since limitations would mean higher prices. * * * It makes but little difference whether the waste is of oil or of money; it is to be deplored. Every competitive enterprise involves more or less economic waste; it is to be expected and is unavoidable. The purposes of civilization have not wholly failed if people are given remunerative employment, even though they are engaged in work which is unessential to some extent. But that philosophy should not be carried too far. Millions of dollars could be saved by the adoption of proper practice in lieu of irrational drilling. * * * A proposed measure (to remedy the drilling evil) was given final study by the (Institute) committee with the result that there was no support for it. It was felt that the owner of a frac-

tional drilling site, without expending his money or taking any risk, would be enabled to realize as much as if he had done so. This would be unfair to the real operators * * * and portions of every oil pool would be cut into fractions solely for the purpose of obtaining this unfair advantage. It might be * * * feasible to reverse the idea and allow the owner of a fractional site to drill upon it, making him liable to those whose property should be unduly drained. * * * I would unqualifiedly advocate an act to make valid and enforceable agreements among operators to suspend competitive drilling operations for given periods. It often happens that pools are extended and oil brought to the surface to be dumped upon the market when there is already a large surplus. This occurs because each producer is unwilling for his neighbor to gain an advantage through aggressive development and drainage. * * * The greatest good will come through channels other than legislative. Occasionally legislation may be needed. * * * In such cases it should be framed by those expert in the matters involved. * * * The work of this board has greatly stimulated research. Already * * * strides have been made, the result largely of interest awakened by the questionnaire. I have in mind the increased recovery of oil from the sands and recovery from abandoned sands. A few—not many—realized how much oil is left in the ground and abandoned apparently forever under present practices until the President sounded the alarm. * * * It is rather shocking to think that with all the brains and engineering ability, with all the inventive genius for which our country is renowned, we should be unable to recover more than one-fourth of the oil in a stratum underground. What we are actually engaged in is a mere skimming operation. * * * Opportunities (for improvements) here are enormous, the reward for success fabulous in amount, and we expect invention on the same scale.

Walter C. Teagle, President Standard Oil Co. of N. J.: ("Fuel Oil and Its Influence on Conservation.") In any discussion of conservation the public thinks in terms of Government action, new laws, artificial restrictions, or some form of controlled operation in the use of raw materials as the only measures for their preservation against future needs. The average man fails to realize that true conservation is economical use. Government action may bring about economical use of a raw material, but generally conservation is more certain of attainment by science and economics. Science, through research, improves methods of production and manufacture. Economics, through price, creates the market. Price expands or contracts production and consumption and is generally the incentive to research. Price is the controlling factor in conservation and so the influence of price is paramount in any consideration of the subject. * * *

The price of fuel oil permits its substitution for coal. * * * It has been suggested that this use be eliminated by law or change in practice which will restrict the production of fuel oil. Such restriction would result in higher prices and would limit the use. This condition, if due only to higher prices, would not of itself be a guarantee that the crude petroleum was being economically used. Two other factors must be considered: (1) Whether economical use of this raw material is not being at-

tained under existing conditions; and (2) whether an attempt to change these conditions by new laws and practices will not raise prices of gasoline and fuel oil unduly and thus make the consumer's cost of the limitations on use out of proportion to the advantage derived.

The petroleum industry has passed through 3 interrelated phases. In the first two the value of a barrel of crude was determined practically by the price paid for a single product. In the early history crude got its value from its kerosene content. With the exception of a comparatively small percentage of lubricating oil, the other by-products were negligible value factors. The kerosene price governed the price of crude; the disposal of the by-product—fuel oil—was more important than the amount realized. When gas and electricity began to displace kerosene the advent of the motor car inaugurated the second phase. Kerosene lost its place to gasoline as the product determining the value of a barrel of crude. The price realized for the fuel oil continued to be merely incidental. As the motor car came into more general use increased demand for gasoline was met largely by running additional quantities of crude, increasing to just that extent the surplus of the by-product—fuel oil—for which a market had to be secured in substitution for coal. The third phase of the cycle of change was reached when the inventive energy of the industry was rewarded in 1912 by the commercial utilization of the creacking still, which for the first time obtained a major product from a source other than crude. This invention and the various processes which materialized during the next few years were limited to the cracking of *distillates*. * * * The price differential between gasoline and the fuel-oil value of the fuel and high sulphur crudes was the incentive for the further development of the cracking processes, perfected within the past two or three years, and the industry is thus for the first time in a position to produce gasoline from them. *Every grade of crude is now a potential source of gasoline.*

What was formerly the by-product—fuel oil—can now be converted into gasoline. The effect is the same as if we had found a new raw material from which motor fuel could be made. *Another source of supply has been created with a lower cost today for the raw material.* * * * This is a distinct and revolutionary change from the days of a spread of as much as 15 cents a gallon between tank-car markets for gasoline and fuel oil. Gasoline produced from the initial distillation is, therefore, no longer the controlling factor in determining the value of a barrel of crude. The price of the by-product—fuel oil—has ceased to be incidental. * * * Although the discovery and development of the cracking principle has not only revolutionized the petroleum situation but has effected a *conservation measure of incalculable value*, it is doubtful if its significance is as yet fully grasped. Cracking has doubled our potential gasoline resources. It has proven that with price incentive further progress in the conversion of the less valuable products of petroleum into the more valuable is certain of accomplishment. * * * The existence of the cracking process and the relatively low price of fuel oil are national safeguards against the uneconomical use of our crude resources. The inevitable conclusion would seem to be that *the conservation of petroleum to meet the demands of the future depends upon price.*

COMMENTS ON THE OIL BOARD'S FIRST REPORT *

I am impressed most favorably.—*J. C. Donnell, Pres., Ohio Oil Co.*

A broad-minded view—altogether reassuring.—*Judson C. Welliver, Director of Public Relations, American Petroleum Institute.*

A mass of essential facts * * * covering every phase of the problem of the country's present and future supplies.—*Bradstreet's.*

The most instructive document relating to the petroleum industry ever issued in Washington.—*Mark L. Requa, U. S. Oil Administrator, World War.*

A good piece of work—the most constructive “investigating” ever executed by a government body.—*Petroleum World of Los Angeles.*

The President's Board does not reflect upon the Committee of Eleven's estimate of a billion acres awaiting prospecting.—*New York Times.*

The opinions expressed are conservative and in favor of encouraging legitimate oil development, free from useless state and Federal interference or control.—*Inland Oil Index.*

The Oil Board saw its origin in a scare and lives up to it in a scare report. But there is nothing that need scare the consumer if the facts are carefully examined.—*Nation's Business.*

The report dispels rumors that the board was considering the testimony to the effect that drastic methods, probably intervention, would be recommended to assure adequacy of future supplies. —*National Petroleum News.*

The report will meet with general approval. In its emphasis on cooperation the board avoids dangers incident to impractical compulsory schemes destructive to individual initiative.—*W. S. Farish, Pres., A. P. I., 1926.*

The board has refused to recommend dumping the duty of regulation upon the Federal Government, a most welcome and refreshing reversal of the tendency exhibited by reform for a generation. Admirable for the general principles asserted.—*Chicago Daily Tribune.*

Misinterpretation of some important findings as given in the preliminary report is common. A careful review shows that above all there are no grounds on which to base the apprehension of an “oil famine.” The six-year estimate considers only the measure of the petroleum in present-known fields where there are producing wells.—*The Oil Trade.*

Report about six years' supply at present rate of consumption has apparently been construed in some quarters to mean that the figure represented the total available reserve in the ground. This is far from the condition existing or the intent of the board. Oil men were rather * * * pleased at evident intent of the Government to cooperate with the industry in its effort to perform efficiently.—*Barron's.*

The report is very constructive. It indicates a willingness on the part of the Government to cooperate with the industry in husbanding present resources and to look with approval upon the efforts of the oil companies to assure themselves of future supplies by incursions into and exploitation of foreign fields. It will be observed that the report speaks of the necessity of going into foreign oil fields.—*George H. Jones, Chairman, Standard Oil Co. of N. J.*

The report is a careful, conservative document. It is again made clear that the most useful thing yet accomplished has been to set a large number of people to thinking about the problems of petroleum and the public. If they think wisely and follow up their conclusions with action, there is no great cause for alarm in the fact that the known proved reserve of petroleum under present conditions of supply is equal to only six years' demand.—*Mining and Metallurgy.*

* The members of the Board are as happy as boys with red-topped boots because of the character of letters it has been receiving from both factions in the oil industry. Every one has been of a commendatory nature.—*Staff Special in National Petroleum News.*

CHAPTER XII. HUMAN FACTORS AND BENEFICIARIES

*"The foundation of business is confidence, which springs from integrity, fair dealing, efficient service, and mutual benefit. * * * Equitable consideration is due in business alike to capital, management, employes, and the public."*—From "Principles of Business Conduct," by Judge Edwin B. Parker.*

THE MEN WHO TOIL AND WIN THE OIL

No Recent Census of Workers in the Oil World. The number of wage earners reported on pages 63 and 83 refer to the middle of 1919 and do not include the figures for the "higher-ups." They totaled 152,011, but would easily exceed 200,000 if to the former were added the number of accountants, chemists, engineers, economists, foremen, geologists, lawyers, managers, salesmen, superintendents, technologists, and numerous others who are identified with oildom. The number now directly employed surely exceeds 300,000—fully a 50 percent increase in six years. "The Oil Industry's Answer"† of April, 1924, claims that there are close to 750,000 employes in all branches, with 3,000,000 dependents.

Participants Compared to Players on a Baseball Team. Such a comparison has already been made, on page 66, but is amplified here. The finders—pioneers or prospectors—may be looked upon as the "pitchers," since they start the ball agoing. The drillers and producers become the "batters" for they sometimes deliver gushers or "flies," which in turn mean so much for the consumers or "fielders." A "dry" or saltwater well may be likened to a foul, which, if caught, makes the batter feel "put out." "Catchers," corresponding to the investors, are naturally not so numerous as the "fielders" or consumers. The last named are often farthest from the oil field as the fielders are most distant from the home base. A safe hit means a good strike of oil, and a home run results in a score like the dividends that follow a gusher of high-gravity oil.

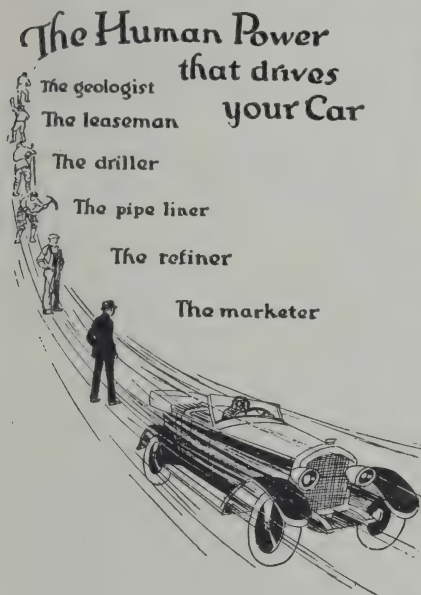
Human Element Intensive, Not Extensive. This element enters more intensely into the successful operation of the petroleum industry than in that of any other great American industry revolving around a single natural resource. According to the last census (1919), 93,122 wage earners in oil and gas produced over \$10,000 worth of products per capita, but 776,569 in coal, not quite \$2,000 each. The intensity of production is even more manifest in the manufacturing phase of the industry. Thus 58,889 wage earners in petroleum refining were each credited with \$27,340 worth of products compared with only \$11,640 worth of motor vehicles produced by each one of 143,658 wage earners in that industry (see pages 63 and 83). The relatively small number of the petroleum employes and their high production per man, whether considering the field or the refinery, is a logical result of two outstanding factors: (1) High efficiency of the skilled labor required, and (2) the fluid form of the natural substance as well as of most of the refined products, which lend themselves to continued mass production at comparatively little outlay for man power. At times the oil flows under natural pressure from deposits one mile deep or more; and it

* Formerly of The Texas Company, but now Umpire, Mixed Claims Commission, Washington, D. C., and Chairman, Committee on Business Ethics, Chamber of Commerce of the United States.

† Published by *The Oil and Gas Journal*, Tulsa, Okla. It evidently allows for workers in wildcatting, transportation, and marketing. H. A. Matier, in *Petroleum World*, Jan., 1906, estimated 45 percent of 250,000 employes engaged in sales.

often runs by either gravity or natural pressure great distances towards its destination. After the gas pressure has subsided, a single attendant at a central pumping plant suffices for handling the output of a score of pumping wells.

Toilers Intelligent and Labor Troubles Rare. It may be said with certainty that in no other important industry does there normally exist so high a ratio between the number of educated or skilled workers and the number of common or uneducated laborers. Only during the development period of new districts, when much building material has to be handled and many pipe lines laid on the surface or in shallow trenches, is there any apparent preponderance of untrained employees. The efficient training* of the work-



—The Lamp.

A STANDARD OIL (N. J.) EMPLOYEE (AT RIGHT) WITH 40 YEARS' RECORD OF FAITHFUL SERVICE

In the house organs of the leading oil operators may be read almost monthly inspiring chronicles of continuous performance of duty rewarded with retirement on a liberal pension and often with concrete expressions of the esteem of their fellow workmen.

ers in connection with the attractive wages generally paid, their participation in earnings through stock ownership (page 288), and the common contentment of the employees, combine in accounting for the really remarkable rarity of strikes and other labor troubles in the American mineral-oil industry. Considering the rapid growth of the latter, its high degree of Americanization, and its geographic shifting, it is indeed surprising how large a percentage of the employees have stuck to their jobs throughout periods of five years or more.

* Read "Teach Your Employee to Think," by C. R. Dooley in *The Nation's Business*, November, 1924; also "Business and Human Beings," by F. C. Kelly in the same monthly, June, 1922; and "Human Relations in a Great Refinery," by G. F. Bush of Cosden & Co., in *The Oil and Gas Journal*, January 24, 1924.

—*The Lamp.*

THE STORY OF THE STANDARD'S TANKS AT BALTIMORE

View of first tank, bottom finished, side plates going up, after blizzard of January 12, 1922.

Qualities Characterizing the Oil Country Clan.* Of the field men even more than of the refinery workers are required the qualities of courage, ingenuity, keenness and unending patience. Their stick-to-it-iveness through day and night, frequently under most trying circumstances, has helped the oil industry to develop faster than any other big business in this country. They, the drillers in particular, are modest men who toil in mud and oil-splashed clothes and carry on just a regular affair. They have much to contend with, such as bad beverages and "rotten" roads in the more unsettled regions. The rule seems to be that the better the oil field the more abominable are the highway conditions (see view of Desdemona or "Hogtown"). (This does not apply to Smackover, where heavy oil and



MUDDY STREET IN DESDEMONA (EASTLAND AND COMANCHE COUNTIES) TEXAS,
AT AUTHOR'S VISIT, NOVEMBER, 1919.

*Adapted from *The Rig and Reel Magazine*, May, 1924, C. A. Metzger, Editor.



RECORD TANK BUILDING AT THE CANTON REFINERY, BALTIMORE

Laying bottom for another tank two days after the big blizzard of January 28, 1922. To store surplus output of Mexican crude during the peak period of 1921-22, six huge steel structures were erected in the short time of 64 days, the working time per tank ranging from 28 to 30½ days. For the complete story of the strong spirit of cooperation, read the details by H. S. Coleman in *The Lamp*, June, 1922.

heavier soil seem to go hand in hand.) Then there are the other followers of the oil fields such as the tank setters or "tankeys." By the very nature of their calling they must be ready to serve under all conditions of the weather—under the blazing sun that makes it hard to handle the hot sheets of steel or in snowstorm or sleet that chills and makes movements slow and uncertain. (See view of record tank building in winter time.)*



—*The Texaco Star*.

SURVEYING 20 YEARS AGO IN TEXAS FOR PIPE LINE TO THE GLENN POOL IN OKLAHOMA

* "The Oldest Tank Builder in the World" is the distinction claimed for John Schnabel, employed over 30 years by the Petroleum Iron Works of Sharon, Pa. He was born in Darmstad, Germany, May 29, 1851, and began tank building at Bradford, Pa., in 1876.



—Manning and Manning

A PAIR OF PROMINENT PETROLEUM GEOLOGISTS

Everette Lee de Golyer is president of the Amerada Petroleum Co. and was formerly (1909-14) chief geologist with the Mexican Eagle Oil Co. William E. Wrather, like the former, was once president of the American Association of Petroleum Geologists. He is now a consulting geologist at Dallas, Tex. See pages 277 and 281.

THE MEN WHO FIND THROUGH WELL TRAINED MIND

Pioneers Possess Supreme Knowledge. The splendid qualities of the tankeys, toolies, line walkers and other worthies would not bring real results were it not for the pioneers or entrepreneurs whose foresight and insight, as genuine geologists or professional oil men, induce them to say, "Here must be oil since surface signs around the soil or cropping rock gives us the clue; so let us drill, and lest we spill petroleum drop in yonder slough, pipe line and tank without a stop we'll rush to build though some will deem us dreamy crank." One case of such uncanny knowledge was the Casiano development in Mexico by E. L. Doheny and his faithful, confident associates (pp. 229-30). Before the first well came in at Casiano in 1910, in fact before any commercial production was obtained in the Southern or Huasteca field, 65 miles of eight-inch pipe line was actually laid, steel tankage was erected near Tampico, and eight large pumps were installed in stations.* No similar feat seems ever to have been attempted in the United States until late in 1924. Asked one noted authority,† "Who-

* See pages 31 and 54-56 in "Mexican Petroleum," by W. J. Archer, who described the conditions and accomplishments as follows: "The simplest food was often hard to get; and after a weary day beneath the scorching sun, slowly carving a way through the jungle, one's night was tortured by insect tribes from which no make-shift shelter afforded protection. To make a pathway through such territory, untouched for centuries, and without knowing what lay ahead, is an acid test of endurance and confidence. * * * Hundreds of workers were employed in cutting down trees and clearing away the thick growth. Barges were built for crossing three rivers (along the route of the pipe line). Water (for steam raising) had to be pumped to the pipe-line stations."

† James McIntyre, in *The Oil and Gas Journal*, December 18, 1924, "Wortham a Field of Unusual Features."

ever heard of an oil company made up of experienced men, building storage at a wildcat well with the conviction of it becoming a producer? And whoever heard of another oil company starting an offset well to a wildcat still drilling—and all on territory condemned by some eminent geologists? The Boyd Oil Company did the one and the Magnolia Petroleum Company did the other.” The former is merely a “Nom-de-plume” for Colonel A. E. Humphreys and his genial geologist and consulting engineer, F. Julius Fohs, to whom references are elsewhere made on pages 70, 145 and 163. Brotherly love between big-hearted operators was never so strongly evidenced as during the remarkably rapid development of this wonder field at Wortham, in Freestone County, Tex., late in 1924.

F. JULIUS FOHS

Chairman, Petroleum Division, Am. Institute of Min. and Met. Engineers, the past two years, having succeeded L. De Golyer in 1925. Mr. Fohs has enjoyed a romantic career with a number of notable discoveries to his credit. Few geologists of his age have met with so much deserved success. He is, like the author, very largely self-taught. He has been very widely quoted in this annual publication.

Along with George Otis Smith Mr. Fohs was elected a vice-president of the Am. Inst. of Min. & Met. Engrs., February, 1927. Thus, with E. L. DeGolyer as its new president, this national body has liberally recognized petroleum in the mineral industry.



Work of the Legitimate Wildcatter. Were it not for this factor who often stakes his all, even borrowed capital, on the chance that a random hole will yield return, the output of petroleum in a country which hitherto has contributed two-thirds of the world's supply would fall to an utterly inadequate figure. The gambling instinct is still the prime motive power that lifts most of the oil obtained in the United States.† It is the speculative character of the work that appeals to the American. In the quest for oil he has unlimited capacity to gratify his desire for quick enrichment.‡ The large producers and refiners, appreciating the value of the speculative oil seeker, foster rather than discourage his activities—contrary to statements made in *The Saturday Evening Post*.** He absolves them from considerable preliminary expense in drilling and proving a new territory. Their work is reduced to purchasing and transporting the raw material

† The optimistic wildcatter is that virile pioneer of the oil field who cheerfully takes the gambler's chance in the hope of reaping a reward commensurate with the risk.—M. L. Requa, author of “War Service of the Petroleum Industry” in *Oildom* (formerly a monthly, now a daily newspaper of Bayonne, N. J.), April, 1918.

‡ Frederick A. Talbot's “The Oil Conquest of the World,” London, 1914.

** *The Literary Digest*, August 30, 1924, “Oil's Undiscovered Romance,” which also refers to Edgar B. Davis, a Massachusetts manufacturer who legitimately wildcatted the Luling field, now among the first five in Texas.



COLONEL A. E. HUMPHREYS

1860-1927

Like some others who have made a signal success in the oil industry, Colonel Humphreys had enjoyed experience previously in other branches of the mineral industry, notably on the Mesaba Iron Range in Minnesota where the author obtained his first practical knowledge of mining. The Colonel was a native of West Virginia where, at Charleston, he built the Boyd Memorial Church in honor of his mother. He now resides at Denver, which is central to his many western activities. His name will ever be associated with Mexia, Powell and Wortham and with the Humphrey's Foundation for helping the needy. While living he gave away four-fifths of a 12½-million fortune. His sad death on May 8, 1927, was due to an accidental gunshot.

when it is tapped. It is a development which is peculiar to the United States. In other oil-producing countries such a tendency is not supported.* Except in rare instances, such as the Gulf Refining and Vacuum Oil at Lockport, La., in 1924; the Shell Company at Long Beach, in 1921, and the Union Oil Company of California at Santa Fe Springs in 1921, and in Colorado, 1923-1924, have large corporations been the discoverers of new pools or fields. They are generally found by individuals, such as M. L. Benedum, E. B. Davis, E. L. Doheny, A. E. Humphreys, E. W. Marland, Thomas B. Slick, Waite Phillips, Oscar R. Howard, and the late Neil Esperson, or else by groups of tenderfeet at the game.

A Preeminent Pioneer in Discovery and Development.† The man who found more oil fields in America than anyone else and who directly or indirectly brought more than a billion barrels of oil above the ground, began prospecting for minerals at the early age of seventeen when he left school in Wisconsin and took to the west. While still in his 'teens he trapped and traded with the Indians; and before Obregon was born he penetrated into Mexico in search for mineral wealth. Later on he located in California, and thirty-four years ago he became interested in petroleum. He produced the first oil in Los Angeles and pioneered the Orange County fields. Twenty-five years ago he was commissioned to find liquid fuel for a Mexican railway. He explored Peruvian oil fields in the nineties. In such prospecting he proved much more successful than the world dean of mining engineers who heads an oil company of his own.

A man of pronounced Christian character, the subject of this brief sketch never gambled, never touched a playing card and never tasted tobacco or intoxicants; and this in a region notorious for miners' saloons and gambling dens. He always kept himself clean of habit, person and speech. From contact with the Indians he acquired that wonderful sixth sense, "orientation." He is direct and straightforward in his speech, which is without doubtful or double-meaning words. Although he never gambled on the turn of the wheel or the tumbling of the dice, he has never looked upon the mining of oil as anything but his own legitimate business. He believes in oil and in its service to man; that handled in a large way petroleum per-

*Frederick A. Talbot in "The Oil Conquest of the World," London, 1914.

†C. W. Barron's "Helping the Government," in *The Wall Street Journal*, February 20, 1924; abstracted and supplemented by the author.

forms the greatest human service with the narrowest margin of profit, and that its market as well as its service is always sure no matter how elusive the liquid may be in its native lairs. John D. Rockefeller was always a merchandiser seeking markets around the world for products made out of mineral oil. He will always be remembered as the world's foremost refiner and the first billionaire to be born. Edward Lawrence Doheny was always a miner, wrestling with nature, and never sought markets for oil when he could sell to manufacturers or merchandisers at a modest profit. He will always be remembered for his Cerro Azul, his fuel oil so essential in the winning of one war, and his patriotic persistence in completing naval facilities for the prevention of another war.

The "Rock Hound" as a Real Factor. A geologist in general is a scientist who is versed in the various subjects that deal with the composition and structure of the earth's crust, the forces which continually cause changes therein, and the ancient life of the earth as revealed in the rock record. The petroleum geologist is an applied scientist who with the aid of geologic theory, surface signs, cores and cuttings, logs of wells and map studies discovers and outlines the particular structures which may contain oil or gas or both. His nicknames are numerous, for he was at first ridiculed by the drillers and others, and these and other intimates now call him "rock hound," "ridge runner," "mud smeller" or "pebble pup." If anything he is cheerful and even facetious despite many discouragements to his profession.



RALPH ARNOLD (RIGHT)

One of the distinguished "graduates" of the U. S. Geological Survey, Dr. Arnold has specialized in California petroleum. He is a graduate of Leland Stanford University, a classmate of H. C. Hoover.

VERNON F. MARSTERS

Mid-Continent petroleum geologist, who has made many oil examinations in South America, notably in Peru. See Chapter X, also proceedings of the Am. Institute of Min. and Met. Engrs.



The essential qualifications of an oil geologist is ability to interpret Nature's indelible imprints in the bedded or stratified rocks, mountains, and valleys, the minor forms of fossils and the minute mineral particles. A thorough knowledge of geologic conditions in any new field will in large measure reduce the hazards and result in immense savings of money and effort. (See pages 12, 40 and 42, 47 and 65).†

Oil Geologists Observe What Others Overlook. Observations made by a geologist differ decidedly from those made by a driller, a warehouseman, or even a financier. This power of professional viewing is well set forth below by a fellow geologist.‡. "For example, look out of the window where you are sitting; what do you see? Now ask your companion to look out of the same window; what does he see? Compare notes and you will be surprised that he, looking at the same objects, has noticed things that you have overlooked. Why? You are a driller, say, so you observed that the well in the foreground was drilling rotary with the tools out of the hole; that there were eighteen stands in the derrick, indicating the depth, and that they were getting ready to run in.

"Your companion is the warehouseman on the lease. Did he see that rig and note what was going on? Not he, for the first thing that he observed was the overshot on a passing truck that he had not been able to locate that morning for the tool pusher. Both of you therefore saw the things in that picture that directly applied to the type of work representing your major interest. The artist, had he also seen that view, would no doubt have been wondering if he could make a picture of oil field atmosphere that he would be proud to initial. All this leads up to the fact that the geologist must be able to see things that Nature presents and then interpret to the best of his ability, what those expressions indicate."

† There still exist many misconceptions among executives as to a geologist's real functions, and so the profession suffers undeserved criticism. It is generally (and wrongfully) supposed that a geologist should be able to predict with certainty the exact spot where commercial deposits of petroleum may be found. If he fails to give such positive and definite predictions, the confidence of the executive is shaken in the whole science of geology. It should be realized that the most important function of the geologist is to advise us as to the places where we can *not* successfully prospect for oil and thus, by a process of elimination, save us many costly mistakes. * * * The p. geologist finds himself dealing with two related lines of activity; the one being correlation work within proven areas and the other being exploration work in wildcat areas."—A. C. McLaughlin in "Geologist Has Earned Place in Oil Industry," an address before the Am. Assn. of Petroleum Geologists, Los Angeles, October, 1923. This authority, just quoted, was a geologist before becoming an executive.

The accomplishments of the chemist in the refining end of the industry must not be ignored. Space permits mere random reference to the three B's: A. P. Bjerregaard, with the Empire Refineries, Inc.; Col. G. A. Burrell, president, Burrell Oil and Gasoline Co., Pittsburgh; and W. M. Burton, president, Standard Oil Co., of Indiana. The second named found the Government helium supply during the war and helped recover gasoline from natural gas. The last named is noted as the inventor of a cracking process (page 107). See *Oil and Gas Journal*, January 31, 1924, "Refinery Chemist an Important Factor," by H. T. Bennett, of Cosden & Co.

Doctor Burton is one of the most distinguished graduates of Western Reserve and Johns Hopkins. He became a chemist for the Standard of Indiana in 1889 and six years later was promoted to general superintendent. He was vice-president, 1915-1918, and since 1918 has been president of his great company. Doctor Burton was awarded the Willard Gibbs medal by the American Chemical Society in 1918, and the Perkins medal by the Society of Chemical Industry in 1921.

‡ C. R. McCollom in *Union Oil Bulletin*, August, 1923.

LADDERS TO LEADERSHIP

Geologists and Engineers Elevated to Executives. The oil industry—more than the Government and the public—is quick to recognize the worth of the technical worker. His education is broad and exacting; his duties develop further definite knowledge, careful reasoning, and good judgment together with diplomacy and fair-mindedness in dealing with his subordinates. No wonder his value is appreciated through his advancement to better paid positions requiring executive ability and thorough training. Among instances of such promotions may be mentioned the cases of Carl Beal, vice-president, Marland* of California; E. DeGolyer, vice-president, Amerada Corporation; E. T. Dumble, vice-president, Rio Bravo Oil Company and dean of western petroleum geologists; F. Julius Fohs, vice-president, Humphreys-Boyd Oil Company; James H. Gardner, president of a Tulsa Company; and, farther down the alphabetical line, A. C. McLaughlin, vice-president, Amalgamated, Associated and Pacific companies. Not to be overlooked is W. W. Orcutt, vice-president, Union Oil of California and dean of California oil geologists.**

The last named founded the geological department of his company and later had also charge of engineering, at the time the author served as one of his assistants. Mr. Orcutt has a quaint way of answering your query about a particular area to the effect that he "feels this is pretty good territory." He "felt" Santa Maria, Richfield, Santa Fe Springs, Dominquez and Rosecrans, but he was naturally annoyed a little when derricks began to destroy the scenery around his handsome home in the Montebello suburb of Los Angeles. Rest assured that his "feel" was not related to the forked stick or other would-be witchcraft, but was backed by countless hours of field work, a wonderful store of technical learning, and the application of everyday simple "horse sense." As a result, the Union Oil Company of California has been highly successful, not only in California but also in Colorado, Texas, Wyoming and foreign fields.*

* "Marland holds a unique position among the small as well as the large producers on account of the excellence of its geological department." C. A. Shively, *N. Y. Evening Post*, January 24, 1925.

** DeGolyer was in 1925 succeeded by Fohs as chairman of the Petroleum section, American Institute of Mining and Metallurgical Engineers. Gardner became president of the American Association of Petroleum Geologists in the spring of 1924, following Max Ball, who is president of the Marine Oil Company, of Denver, Colo. Valentine Garfias, former associate of Ralph Arnold, is manager of the foreign department of H. L. Doherty & Company. W. A. J. M. van der Gracht (page 44) is president of the Marland Company of Texas. Read "The Petroleum Executive and Geology" by J. H. Jenkins, chief geologist, Tidal Oil Company, in *The Oil Weekly*, December 23, 1922.

"Graduates" from the Geological Survey have distinguished themselves in private enterprise. To a few of these references have been made in Chapter XI. Ralph Arnold is a classmate of Secretary Hoover and noted for his reports on California geology. Messrs. Ball and Beal (see above) are both former U. S. G. S. men. Other ex-Survey geologists include C. F. Bowen, chief g., Standard of N. J.; F. G. Clapp, of the Associated Petroleum Geologists; Everett DeGolyer, pres., Amerada Corp.; Alex. Deussen, v. p., Marland Oil of Texas; A. E. Fath, chief g., Vacuum Oil; C. A. Fisher, consulting g., Denver; F. Julius Fohs, still (1926) chairman, Pet. Division, A. I. M. E.; H. S. Gale, cons. g., Los Angeles; J. H. Gardner, producer, Tulsa; C. J. Hares, chief g., Ohio Oil Co.; K. C. Heald, staff g., the Gulf Companies; E. B. Hopkins, cons. g. (Venezuelan oil), New York; O. B. Hopkins, chief g., Imperial Oil (of Canada); Robt. T. Hill, cons. engr., Dallas; J. A. Taff, chief g., Pacific Oil; C. W. Washburne, cons. g., New York; C. H. Wegemann, chief g., Pan American (Eastern).

* According to *The Wall Street Journal*, February 14, 1925, the Union Oil Company of California profited \$22,000,000 in 1924. Of this, \$10,700,000 was net for the stock after deductions for return of capital, and was 25 percent larger than in 1923. Inventories of crude and refined oils, aggregating 23,500,000 barrels, were worth alone \$35,000,000 at 1925 prices.

Lawyers Likewise Become Leaders. Not all the captains and mates of the oil industry work their way up from the crew or the engine room, for some were lawyers before they entered the legitimate oil industry. But the percentage is much smaller than, for instance, in the case of Congress, the membership of which is made up of more than 65 per cent of attorneys, an altogether unfair preponderance from one profession. Brilliant brains with legal training find the oil industry very attractive although litigations are not nearly so numerous as in metal mining whereof the land laws are comparatively complicated. Among prominent attorneys who have specialized in the practice of petroleum law may be mentioned Frederic Kellogg, former law partner of ex-Secretary Hughes, and now with the Pan American Petroleum & Transport Co.; "Judge" Charles E. Kern, now the Washington correspondent of the leading American petroleum journal; and Judge Edwin B. Parker, long counsel for the Texas Company but since 1923 the American commissioner and umpire, Mixed Claims Commission, United States and Germany. It is quite true that knowledge of law alone does not qualify a man for high executive position in the oil world. Invariably, like the engineers and geologists who are advanced to administrative jobs, the lawyer must be balanced with common sense and leadership ability, as illustrated below.

Four Very Able Attorneys Now Active Administrators. Colonel Robert W. Stewart was a farmer boy in Iowa before he practiced law in South Dakota and became a State Senator. As a major in the "Rough Riders" he fought under Roosevelt. Since 1907 he has been successively promoted from general attorney to general counsel and to chairman of the board, Standard Oil Company of Indiana. He has popularized his company with its employes perhaps more than any other man (see Stockownership by Employes). E. W. Marland, president of his company, was a country lawyer in Pennsylvania before moving to Oklahoma. His beautiful home and his company's headquarters are located in Ponca City in the heart of the high-grade pools of the Mid-Continent. Frederick H. Wickett is chairman, board of directors, Pan American Eastern. At the age of 21 he became assistant attorney for the old Chicago & Northern Pacific Railway

W. F. RITTMAN, Chemical Engineer

As research engineer with the Bureau of Mines investigated conditions applying to the cracking of heavy oil for the manufacture of gasoline and also of benzol-toluol used in explosives manufacture.

He is now head of the Commercial Engineering Dept., Carnegie Institute of Technology.

Doctor Rittman is also well known as a consulting engineer to the petroleum industry.



Co. He entered the oil business in 1916 when he organized the Dixie Oil Co. in Louisiana. Amos L. Beaty became attorney for The Texas Company in 1907 and in 1920 succeeded the engineer, E. C. Lufkin, as president of that great independent.* On account of ill health, the latter retired from the chairmanship of the board and was relieved by Judge Beaty in March, 1926, the presidency being taken over by R. C. Holmes.

The Engineer and the Human Element.** In mining it has already been found that the best man for manager is he who has had engineering training. Managers up from the office, the purchasing department, or the transport department may make good, but not so good as those who have had technical training. A manager must needs speak the language of his staff. While the capitalists realize this, the engineers on their part have just begun to see, during the last few years, that mere knowledge of machines and of Nature's forces is not sufficient. The human side of engineering is all-important. Executives from the highest down to the lowest should understand something of psychology and the handling of men. The whole idea of a successful foreman has entirely changed in twenty years. No longer is that foreman great who can lick anybody in his gang. Industry now wants the foreman (and the engineer) who gets his men to work not *for* him but *with* him. In other words, cooperation can be classed with conservation and standardization as a forward step in procuring and maintaining prosperity in the petroleum industry as well as in the mineral industry at large.

TREASURE OR TRAGEDY?

The Driller, Despot of the Derrick. Foremost among the human factors attending the success or failure of an oil well is the man who manipulates the drill. Within his realm lies the power to ruin the well he is drilling. This may be done through carelessness, neglect, inexperience, or even deliberate intent if he harbors a grudge against his employer. But usually his whole soul is wrapped up in the problem of "making hole" or finding oil in behalf of his backer. The life of a driller is a hard one and only a man physically strong, mentally alert and spiritually courageous can "carry on" as he must do for a long time in 12-hour shifts or "tours."† The successful driller at a standard rig has mastered the technique to control the bit or drill operating at the end of a cable which may extend from a few hundred feet to more than a mile below the floor of the derrick. This man must meet all kinds of emergencies. The arduous life which he has to lead is forcefully set forth by a reputable writer. What is said in the following quotation applies as well to the driller's able assistant—the

* Partly abstracted from *The Nation's Business*, November, 1924. The modesty of Mr. Marland is reflected in the fact that his biography is conspicuously absent from "Who's Who in America." The brief biography of E. L. Doheny fails to bring out the fact that he studied law during leisure time and was admitted to the bar many years ago; also the fact that he surveyed boundary lines in Oklahoma long before its oil industry was born.

** Abstracted from article by J. Parke Channing in *Mining and Metallurgy*, May, 1923.

Probably now the most noted engineer among oildom's executives is Geo. S. Davison, president of the Gulf Refining Co. His popularity is further evidenced by his election, in 1926, to the presidency of the Am. Society of Civil Engineers.

† About the middle of 1925 the Standard Oil Company of New Jersey inaugurated the 8-hour shift and others quickly followed. This means that the largest Standard Company must employ 500 more men.

toolie—the tireless trouble-shooter, ambitious to become a driller without undue delay.

A Leaf from a Driller's Diary.* Called at 11 p. m.; sleepily turned out of a hard but warm bunk; joined at the bare board table by other drillers and tool dressers. Quietly quaffed weak coffee and ate fat meat and soggy bread.** Used to rough surroundings, always at the front, pioneering a new field. Rough work and plain food was their portion, and to their credit they never kicked. Strode the driller along in the darkness, whistling as he went. He knew this land and this life which he loved so well. He had tagged the goddess of fortune from the hills of Pennsylvania to the far corners of the earth. He had frozen a foot at Fort Norman and in Rangoon was bedridden with fever. Luck had failed him, yet he never whimpered. He was a sticker and a man—this driller. He was a big man with iron-gray hair and with eyes that looked unafraid at the universe. The driller stood on his stool, hand on the temper-screw. Delicately attuned fingers felt what was happening 3,000 feet below—whether the bit was biting into hard sand or soft shale. He panned out some screw. The walking beam kept up its steady “plaint”—up and down.

Fortune or Failure. They pulled tools and bailed out. The driller scooped up some sludge, then shook his head, for it did not look or smell like oil. Drilling again towards daybreak, one more screw would tell the tale. Impatiently the owner waited, pacing about the derrick floor. Slowly the tools were pulled to the top. The bailer was run, and again the driller examined the sludge. He answered the frantic question in the owner's eyes: “Dry as the bunkers o' hell!” The owner gasped; he wrung his hands. He had dropped his last dollar and all he could beg and borrow. Though there was no money for paying the crew, the driller neither swore nor protested. He had drilled once for himself and knew how the owner felt.†

Hazards and Heroes. The loss of a month's wages is the least of the limitless risks run by a driller when a dry test is completed. Sometimes, as the contractor, he is induced to take half his pay in shares of what may prove a profitless venture. The coal miner escapes from such participation but when it comes to a question of fatal and non-fatal accidents he has a lead over the oil field and refinery workers with an annual death toll ranging from 2,000 to 2,800.‡ Unhappily, and with the exception of underground coal mining, the oil business has more physical hazards to the square yard than any other large industry. The bodily risks pertain to (1) construction, of derricks in particular; (2) drilling operations, as in handling heavy tools; (3) bringing in wells, involving possible demolition

* Slightly modified from an article by H. Botsford in *Oil Trade Journal*, August, 1923.

** As a matter of fact, the modern driller is not satisfied any longer with the plain “grub” of the good old days. Most operators now vie with each other in their various camps in catering to their faithful field men.

† The author, too, has shared a similar feeling for he has helped to pay for three “dry” tests in Texas and one rather recently—over 4,500 feet deep—in West Virginia. Such losses are compensated, however, when oil or gas is found, for the consumer must pay for the dry wells as well as for those producing.

‡ During the past 15 years; equivalent to a death rate of 3.78 to 5.54 per 1,000 300-day workers. The corresponding rate in California oil fields varied from 1.29 in 1917 to 2.72 in 1923.

of derrick, blowing out of drill stem and bit from hole, explosion of gas, or burning of oil; (4) ignition of oil in storage tanks, especially by lightning; (5) asphyxiation from fumes in cleaning out land tanks, tank cars or ships' tanks; (6) welding pipe lines with acetylene; (7) casinghead plants; and (8) refineries.

References are made to a few spectacular cases where hazards to humans have been involved. One of the most fatal if not the costliest of catastrophes in the history of the petroleum industry happened near Corsicana, in Navarro County, Tex., in May of 1923. The Hughes-McKie gusher in the Powell field then came in, spouting 5,000 barrels of oil and about 2,000,000 cubic feet of gas. While getting the flow under control the gas ignited, and instantly the oil stream changed into a seething, fiery monster.* Only five of the eighteen men at the well were able to escape with their lives. Just how the gas caught fire is not definitely known; it was likely not due to the baneful cigarette—the meanest menace around a well or a refinery. The conflagration was finally conquered by a method originated in Mexico and afterwards used in various places, as at Pelican Rapids, 165 miles north of Edmonton in Alberta.** Exceptional heroism was displayed not only at this disaster but at many other fires in oil fields. Even without fires bravery is brought into play, especially in capturing wild wells. A group of American heroes like those who jailed the giant Cerro Azul south of the Rio Grande is shown on page 232. "Happy" O. P. Yowell was the Long Beach forward in a fight of "Ten Men Against a Geyser of Oil," which occurred in California about four years ago.† In May, 1924, M. M. Kinley flew from Tulsa to the Cromwell field in an overloaded airplane with 18 quarts of gelatine which he used in snuffing out a burning gasser rated at 32,000,000 cubic feet.‡

WELFARE WORK AND COOPERATION

How Big Oil Companies Care for Employees.§ All corporations are naturally interested in any kind of welfare work that will redound to their own advantage. Truly, one cannot conceive of any effort expended for sociological betterment but what eventually brings bountiful returns to the benefactor, directly or indirectly. It is characteristic of the petroleum industry that its corporations as well as individual operators take a decidedly human interest in all who serve them without arousing that resentment with which some mining companies once had to contend. Perhaps this difference in appreciation is due to the fact that there are relatively fewer suspicious foreigners employed in oil fields and refineries than in mines, mills and quarries. Americans realize that they receive merely

* "The Hughes Corsicana Gusher," *The Rig and Reel Magazine*, July, 1923. (See also April, 1924.)

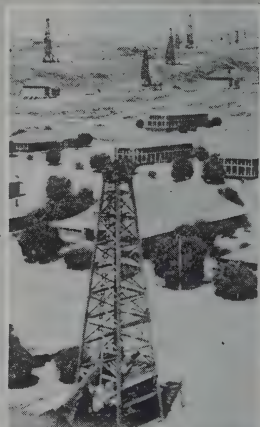
** "Recapping Wild Well Tests Nerve and Ingenuity," *Engineering and Mining Press*, September 29, 1923.

† *Literary Digest*, March 24, 1923.

‡ "Courage, Gelatin and an Asbestos Suit," *The Oil and Gas Journal*, May 22, 1924.

Read also "Fire and Explosion Hazards of Petroleum and Petroleum Products," Serial No. 2400, September, 1922, by Messrs. Katz and Smith of the Bureau of Mines; "Safety in the Petroleum Industry," by H. Foster Bain, *The Oil Weekly*, December 9, 1922; "Promote Safety and Reduce Time Losses," shows what a cigarette did and tells about the work of the Texas Safety Council in *The Oil Weekly*, February 6, 1924.

§ Partly abstracted from an article in "The Oil Weekly." See Union Oil "Bulletin," Jan., 1925.



—Rig and Reel

THE HOUSING PROBLEM IS HAPPILY SOLVED BY THE OPERATORS
The lowest scene is in Zacamixtle, Mexico, showing a thatched hut.

a square deal—not charity to partly replace wages or salaries, or to prevent merited increases therein. Company care for employes is manifested in many ways that make for economy, efficiency and real prosperity.

Annuities are based upon length of service, 20 to 30 years being required with 65 years as the retirement age, and \$300 as the least annual payment, average earnings being a controlling factor. *Life insurance* is paid to dependents commensurate also with the salary of wages and the period of employment; and to entitle them to a sum equal to a year's earnings the deceased must have worked not less than five years and in the case of some companies, as long as 10 or 15 years. In this connection there have been formed, at some of the larger refineries, mutual benefit associations one of which early in 1924 had \$35,000 to its credit. *Compensation for accidents* is now commonly provided directly by the companies themselves at considerable saving.* *Sick benefits* are usually confined to free medical attention and hospital treatment, but some companies go so far as to furnish visiting nurses and calls by the physicians to families of employes. The Standard of California has even built a *sanatorium* for tubercular patients at Colfax where the climate is favorable. To further the health of its men in isolated places another company uses a traveling *bath wagon*. Most companies provide pure food at little more than cost, and one concern has established a *cafeteria*. *Recreational advantages* vary from swimming pools to fully equipped club houses with libraries, like the one the author found at Ebano, original headquarters of the Mexican Petroleum Company, 40 miles west of Tampico. Few industries take greater pains to encourage *education* among employes than the oil industry. This takes different forms such as traveling libraries, house organs, occasional lectures or movies, evening classes for foreigners and technical instruction for selected employes.† Day schools for children have been built and maintained in out-of-the-way places.

Industrial Representation in the Standard Oil Co.‡ The labor policy of the Standard Oil Co. (New Jersey) is founded on paying at least the prevailing scale of wages in the community; on the eight-hour day, with time and one-half for overtime; one day's rest in seven; sanitary and up-to-date working conditions; just treatment assured each employe; payment of accident benefits beyond the amount prescribed by the State compensation law; health supervision by a competent medical staff; payment of sickness benefits after one year's service; cooperation with employes in promoting thrift and better social and housing conditions; and assurance for a generous annuity at the age of 65, guaranteed for life after 20 years of service. Most of these features have been a part of the company's policy for many years, but it is only during the past two years that the cooperation of employes in determining these matters has been definitely assured through industrial representation.

Industrial representation, in the Standard Oil Company, is a principle

* Abstracted from A. R. McTee's article in *The Oil Weekly*, February 9, 1924, "Oil Companies Show Saving by Carrying Own Liability Risk," by J. C. Chatfield in *National Petroleum News*, March 19, 1924.

† As typical of what the thoughtful operators do for their employes read "Humble Office People Have Own School," by W. V. Gross in *The Oil Weekly*, November 7, 1924.

‡ By Clarence J. Hicks, New York, N. Y., in *Mining and Metallurgy*, March, 1920.

rather than a procedure. Representatives of employes and representatives of management evolved a simple plan, the basis of which is that it gives every individual employe representation at joint conferences on problems and fundamental principles affecting all those interested in the industry. Experience has definitely shown that representatives of the employes are not only alert for the employes' interests but are as keen as the representatives of the management in determining and insisting upon fairness to the employer. The plan was brought into operation by an invitation to employes to cooperate in maintaining the company's policy.

STOCK OWNERSHIP IN OIL COMPANIES BY EMPLOYES AND CUSTOMERS

Mutual Treasures with Tragedies Unknown. Men buy stock in companies they trust. They try to protect companies in which they own stock. And when the company whose stock they buy and own is the one for which they work, then we have evidence of the two finest characters in industry—an employer deserving of confidence, and a worker who is keen about his job. Warren S. Stone, bank president and president of the Brotherhood of Locomotive Engineers, said: "The saving power of American workmen is so great that, if they would save and carefully invest their savings, in ten years they could become one of the dominating financial powers of the world." The idle prophets of warfare between capital and labor are daily being confounded, and they don't know it. If there is any class war, it is between the Realists and the Ranters, and it is merrily going on right now. You know who is winning—the workmen themselves!*

Extension of Employee Stock Ownership. To encourage thrift all the larger oil companies have introduced plans for stock purchase and ownership by all workers. The general rule permits the employe to invest part of his salary, never more than one-fourth, in company stock each month. Practically all the operators popularize the plan by investing half as much for the employe as he invests for himself. One prefers to let the workers pay on installments and in the meantime draw the dividends with which to help meet the payments. As of December 31, 1924, 14,100 employes of the Standard of New Jersey were credited with 537,237 shares of common stock having a market value of \$24,600,000 on February 1, 1925. This amount is exceeded only by the holdings of John D. Rockefeller, Jr., Northern Finance Corp., Rockefeller Foundation, Harkness estate, and General Education Board.† Since Col. R. W. Stewart became the directorate chairman of Standard, Indiana, the number of stockholders has advanced from 4,600 to almost 20,000, chiefly through employes' purchases. In four of the company's plants 70 per cent of all the workers were recently stockholders. No single shareholder in Standard of Indiana owns over 10 per cent of its capital stock. In 1916 the Union Oil Company of California inaugurated profit-sharing (without actual stock-ownership). Since then about \$5,000,000 has been disbursed, \$800,000 of which was paid to 6,000 employes out of the 1924 net earnings. General Petroleum initiated a similar plan at the end of 1920; the Magnolia Petroleum Co. early in 1924, and many other companies in California, Texas and elsewhere have

* With the exception of the last three words, this is part of an editorial by Merle Thorpe in *Nations Business*, March, 1925. See Arthur Pound's story in *The Independent*.

† *Wall Street Journal*, February 2, 1925. *Stanford*, September, 1923.



OUTING OF THE TEXAS CO.'S EMPLOYEES AT SCHUETZER PARK, ALBANY, N. Y.

The following towns were represented: Saratoga, Waterville, New York City, Hudson, Cobleskill, Schenectady, Gloversville, Ft. Plain.

done likewise. Thus, in The Texas Co., nearly all in positions of importance and many in minor places own shares. Their holdings grow larger every year, and frugal ones look forward to retirement upon comfortable income from this source. Stock ownership makes for unity of effort and purpose; and it increases the number of sentinels who will not go to sleep.*

On February 24, 1926, about \$40,000,000 worth of stock was delivered by the Standard of N. J. to employee-subscribers who had been saving regularly to pay for it. That makes for happiness, freedom and prosperity. In the spring of 1926 about 42 percent of the capital stock of the Standard of Indiana was owned by 15,722 employees. Chairman Stewart thereof says that all the directors of his company may some day be elected by the vote of employees. Under a new plan, Standard of Indiana contributes 50 cents for each dollar subscribed for stock purchase by employees. See "Wall Street Journal," March 6 and May 14, 1926.

Customer Ownership of Stock in Oil Companies. Detailed data regarding the extent of customer ownership in petroleum enterprises are not yet available. It is very likely that the practice is more common in non-oil industries. But with every American considered a consumer or buyer of petroleum products it may be said in general that every shareholder in an oil company is a customer of that or some other oil company. But the reverse, of course, is not true, particularly when customer ownership is considered to be confined to the purchase of stock only in the company or companies with which each buyer deals directly in procuring his petro-

* *The Texaco Star*, May, 1923, editorial by A. Lefevre. See also "What Do Employees Want," by D. A. Callaway, June, 1924, page 16. According to *The Wall Street Journal* of January 22, 1925, The Texas Co. has allotted to employees almost 80,000 shares at \$35 for the year 1925. This is under market value, indicating that the company contributes substantially.

leum supplies. However, a survey has just been completed showing that stockholders in a leading group of basic industries increased by 3,500,000, or virtually doubled, between January 1, 1918, and January 1, 1925. This related to 523 corporations, many of whom belonged to one branch or another of the oil industry. Of the great increase, almost equal to the population of California, 500,000 were estimated to be employees, 1,000,000 customers, and 2,000,000 investors drawn from the general public.*

THE SERVICE OF GREAT FORTUNES †

For the heights by great men reached and kept
 Were not attained by sudden flight;
 But they, while their companions slept,
 Were toiling upward in the night.—*Anonymous.*

The Two Richest Men the World has Ever Known Compared With Others. They are the two who have accomplished the greatest material good in the world, and they happen to be at present alive and in the enjoyment of good health. No fortune in England or Europe, either by income, capital account, or landed wealth, ever approached the millions that are under the name of Ford or Rockefeller. Judging by income, Lord Iveagh, the brewer, is probably the richest man in Great Britain; but his fortune is hardly half, and possibly only one-quarter, that of either Ford or Rockefeller. In shipping circles some give second place in the line of wealth to Lord Pirie, the ship builder, with an estimated income of £3,000,000. He is one of the shrewdest business men, and it is said he is building every ship for oil burning. In general, however, shipping people will tell you that the richest man in England is Sir John Ellerman. He is not only a skillful ship operator but he is also a large owner in the *London Times*.

A British Engineer Founded the Foremost Crude Oil Producer. If a census of rich men of England could be taken it would astonish people to find Lord Cowdray ranking very near the top. Here again it is service—world-wide service—that brings the return. More than 30 great engineering feats stand to the credit of Cowdry around the world, from the Pennsylvania tunnel under the Hudson and constructions at Vera Cruz and Tehuantepec to large enterprises in Egypt. The world seems an economic unit with Cowdry. He expanded the Mexican Eagle in Mexico until it ranked as the biggest oil producer in the world. When it had a value of more than \$100,000,000 he let the Royal Dutch and Shell people have it to round out their enterprises. He is now building the great Makwar Dam on the White Nile, of which nearly nothing is heard in America but which is almost as important as the famous Assouam Dam. While waiting for England and France to join hands and demand that he build the Dover tunnel he steps over to California on a pleasure trip and quickly inspects not only the Grand Canyon of the Colorado but Los Angeles and the whole Pacific coast to British Columbia.

* Survey by R. S. Binkerd of the Academy of Political Science, according to *The (Washington) Evening Star*, March 9, 1925.

† Written by C. W. Barron, the leading financial authority, on his return from London. and reprinted in the *Boston News Bureau*, Jan. 26, 1923. Lord Cowdray died in May, 1927.

LATE OCTOGENARIANS—OLDER THAN OILDOM

Lives of Oil Men Oft Remind Us We Can Lengthen Our Lives, Too. There must be something medicinal about the oil business, since so many of its members attain a ripe old age. Perhaps petroleum serves as a germicide as well as an insecticide (page 123); or perhaps the longevity of so many oil men is due to their living in the open, away from the polluted air and the congested streets of our American cities; or probably they have healthy habits, enjoying hard work and partaking of plain food, leaving liquor and cigarettes largely alone.

"Far from the maddening crowd's ignoble strife
Their sober wishes never learned to stray."

—Gray's *Elegy*.

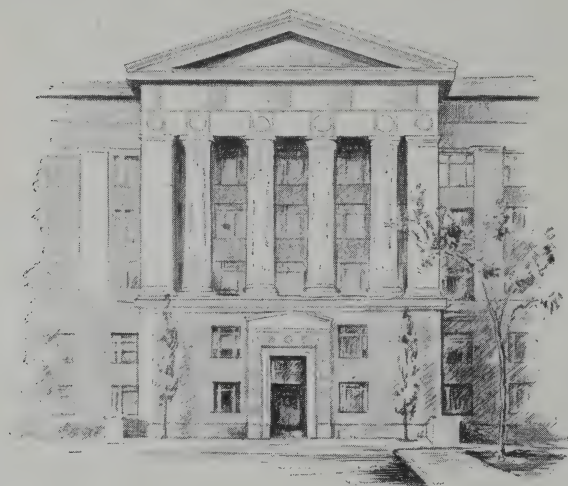
At any rate, one can not help but notice among the necrologies appearing in oil periodicals that the men who make their mark in this industry almost invariably reach a ripe old age. William Rockefeller was in his eighty-first year when he died in April, 1922. His more famous brother entered his eighty-seventh year on July 8, 1925. He governs his appetite and prefers to walk and wield a golf stick rather than ride to excess in a "gas wagon."

Lyman Stewart Lived Over Eighty-three Years. To this late leader of the petroleum industry in California the author, a former employe of the Union Oil Company of California, has properly dedicated this volume (see frontispiece). Mr. Stewart's connection with the oil industry antedated that of John D. Rockefeller by more than two years. But fortune did not come to him quite so fast. His career was one of continuous struggle, intermingled success and failure, with triumph attended in later life. A less resolute man would have been crushed by the reverses and hardships which were the lot of Lyman Stewart particularly after leaving Pennsylvania and locating in California. He and E. L. Doheny deserve more credit than any other two men in putting California on the petroleum map. A monument to Mr. Stewart's memory is the big Bible Institute on Hope Street in Los Angeles.

Dr. Bridge Helped to Place Mexico on the Oil Map. Early in 1925 there passed away a prince of patriots. A nature's nobleman was Dr. Norman Bridge. A cleaner or more courageous man never lived. In order to rid himself of tubercular trouble he gave up his active professorship at Rush Medical College in 1901, at the age of 56, and spent his winters thereafter on the Pacific Coast. In 1906 he became one of the several associates of E. L. Doheny in pioneering the Southern or Huasteca fields in Mexico, making it possible, ten years later, to provide an ample supply of fuel oil for the allies. During the World War he acted as chairman of the National Enemy Relief Committee at Washington. Dr. Bridge served three years as president of the Chicago Board of Education and was otherwise widely interested in the dissemination of knowledge. He gave \$600,000 to the California Institute of Technology* while living. The bulk of his estate, valued at almost \$8,000,000, will eventually be equally divided

* Defended in June, 1911, by the author from an attack in a mining journal. Doctor Bridge was then a member of the Board of Trustees of this institution then known as "Throop" and presided over by the distinguished James A. B. Scherer.

among five institutions. These include the universities of Chicago and of Southern California. In an address delivered December 6, 1921, Mr. Doheny said of Dr. Bridge: "His beaming intelligence, faith in his associates, cheerful and equable disposition made him an invaluable companion and business associate." Like Franklin Knight Lane, Dr. Bridge was a vice-president of the Pan-American Petroleum and Transport Company at the time of his death.



**EXTERIOR OF THE
MELLON INSTITUTE OF
INDUSTRIAL RESEARCH**

This was established in honor of the late father of the Secretary of the Treasury. It is operated in connection with the University of Pittsburgh and offers many opportunities to scientific workers.

INSTITUTIONS ENDOWED FROM OIL DIVIDENDS

Mellon Millions Establish Industrial Research. The Mellon Institute of Industrial Research and School of Specific Industries is housed in a Greek temple adjoining the University of Pittsburgh, built by Andrew W. Mellon and his brother Richard B. as a memorial to their father. The idea originated in 1907 with Dr. Robert K. Duncan, of Kansas, who became its first director. The wide scope is indicated by the fact that there are 52 different fellowships with 81 scientists at work. Baking and laundrying are among the many arts given attention. The Institute contributed two things to the winning of the war: gas masks and toluene for making TNT (see page 59).

Rockefeller Riches Benefit Innumerable Institutions. The gifts of John D. Rockefeller and his son for the uplift of humanity approximate to date the huge sum of \$600,000,000. Carnegie and Frick, both steel magnates, have given respectively \$350,000,000 and \$85,000,000; Hershey, \$60,000,000; Eastman, \$58,600,000; Mrs. Russell Sage, \$40,000,000; Duke (the tobaccoist), \$40,000,000, and Henry Phipps, \$31,650,000. The Rockefeller Foundation alone has dispensed over \$80,000,000 in all parts of the world for preventing disease and plague. It fights malaria in South America, hookworm in India and our southern states, yellow fever in the Panama Canal Zone; tuberculosis in France, and typhoid wherever it may appear. Its head is Dr. George E. Vincent. Then there is the Rockefeller Institute for Medical Research of which Dr. Simon Flexner is the director.

THE PEOPLE WHO PROFIT FROM PETROLEUM

The Beneficiaries of the Oil Industry are not alone the employes on the one hand nor the Cowdrays, Fords and Rockefellers on the other. Millions of people of modest means enjoy in some way the fruits of efforts and funds spent in the search for, and the production of, petroleum. The Osage Indians in Oklahoma, and white and colored farmers there and in other States are recipients of bonuses and rentals before their lands are tested and of royalties after oil has been struck. The leasers and speculators do not always receive the lion's share. The operators and stockholders are supposed to get great dividends, and often they do, but still oftener they do not. The greatest and steadiest beneficiaries are those who in one way or another utilize the products in the forms of gasoline, kerosene, fuel oil, paraffin and lubricants (see pages 58 and 94). Consumers of the 300 or more products obtained from petroleum include all classes of people.

The Farmer is Probably the Biggest Beneficiary, for, aside from what lessors' income he may have, his labor is lightened, his time is saved and his pleasures multiplied much more than any other great occupational group since he is not only the most numerous but as an individual a more varied consumer than the city dweller. The latter, for instance, rarely illuminates his home with the kerosene lamp and does not always preserve foods as the farmer's wife does, with the aid of paraffin wax for sealing. Oil burning equipment has increased his capacity for raising crops (see page 20), trucks quickly take his perishable produce to nearby markets, and his family enjoys better church and school facilities than formerly (see page 128).

Mankind Mounting Higher With the Help of Mineral Oil. But the banker and the bricklayer are likewise benefited though in fewer respects. The metal miner now pays less for paraffin candles than he formerly did for the tallow illuminant. Petroleum oils, ointments and lotions find a place in our hospitals and homes for soothing the suffering. Operators of all kinds of machinery—dynamos, elevators, gas engines, hoists, locomotives, lathes, power plants, airplanes, cranes, drills, steam shovels and ship's engines—could not turn a wheel without lubricants of many kinds derived from petroleum (see pages 94-97 and 123). In fact, modern civilization and industry such as we know it, simply could not exist without the products of mineral oil. Who, after all, is the real beneficiary of the oil industry if it is not civilized mankind? Do the benefactions stop even here? No, indeed; for savages and the semi-civilized share in its showers of blessings through their material, mental and spiritual uplift brought about by the agents of commerce (Chap. VIII), of mercy (page 5), and of missions which are more or less fostered or financed with the private fortunes made out of mineral oil.

Security Holders Not Even Second Fiddlers. Critics of the socialistic kind look upon the "bloated" bondholders and stockholders as a class most substantially supported by the oil industry. This is not true, although some individuals receive greater returns through stock ownership than the highest officials get income in salary form. There appears to exist an inexorable but unpublished priority rule in the distribution of gross income as there should be in the quality of consumption (page 95). First come the lessors or land-

owners; next come the wage earners and the dealers in equipment and supplies; third come the salaried officials with the smallest percentage of all; fourth come the bondholders who are non-existent as far as the net earnings above fixed charges are concerned; and fifth and finally come the holders of preferred and common stock. The last group get their share of the gross income only at the small end of the horn after it has been successively shrunk and given the names of "net income," ordinary net profit, net after depletion and depreciation, net after taxes, and net available for dividends and surplus.

Statistics of Stockholders—Widening Ownership the Outstanding Feature. The ever-expanding public ownership in large American corporations has been characterized as "a peaceful economic revolution."^{*} The movement has gathered momentum mostly since 1920, although beginning during the war. It has manifested itself in two directions, towards customer ownership and towards employee ownership (see below). Two instances are cited to illustrate the recent diffusion of securities, one among smaller and one among larger concerns. On April 10, 1920, the Ventura Consolidated Oil Fields, a California operator with New England capital, had 1,116 stockholders. On April 16, 1923, it had 2,872 stockholders, making a three-year increase of 150 per cent. Similarly, in three years, the Sinclair Consolidated Oil Corporation multiplied its number of shareholders from 20,660 on August 31, 1920, to 40,549 on August 31, 1923, a gain of nearly 100 per cent. To show how numerous are the individuals interested in some of our leading American corporations the following figures are given as representing the number of stockholders at the end of 1923 or the beginning of 1924:

Bell Telephone	485,000	Standard of N. J. [†]	61,490
Durant Motors	300,000	Standard of Calif.	10,904
Am. Telephone	281,149	Sinclair	40,549
U. S. Steel Corp.	154,230	The Texas Co.	30,000
General Motors	68,281	Union Oil of Calif. [‡]	4,000

Standard Oil Bulletin of May, 1923, reported 10,904 as the number of its stockholders as of December 31, 1922, the same as the number of employees participating in profits, with \$9,234,741.50 to their credit as invested in the company's capital stock. There were either more than 10,904 stockholders altogether or there were fewer than that many participating employees.

Opulent Osages, World's Wealthiest Tribe. "Oil fortune does not draw the color line."^{**} For years the Osage Indians were nomads, merely wards

^{*} Prof. T. N. Carver, of Harvard, quoted in the *Washington Star* by M. S. Rukeyser, who writes that "the development of the huge corporate enterprises wiped out many smaller, weaker, one-man organizations of an earlier generation. The new crop of American youths is finding its opportunity more and more in jobs rather than in their own businesses. The salaries offered at the top are often far beyond what might have been earned as independent operators."

[†] Standard of New Jersey reports this number in addition to 12,928 subscribers to employees' stock acquisition plan.

[‡] *The Wall Street Journal* of July 15, 1924, reported 5,000 persons owning Union Oil and Union Oil Association stock.

^{**} The black man as well as the red man shares in the showers of blessings that follow the finding of oil in land which he may own. He may even help to discover new pools as was the case with the negro hunter, Joe Tillman, whose observation of gas seepages 7 miles southwest of Lake Charles near the Gulf Coast led to joint development by the Gulf Refining Co. of Louisiana and the Vacuum Oil Co., in 1924 (page 25, *Washington Star*, Nov. 4, 1924). See also *The Rig and Reel*, August, 1922; *Washington Times*, June 4, 1922, "Where Negroes are Made Millionaires in a Day."

of the masterful white man. From the Far South they trekked to Kansas, and finally, by the grace of government, settled in Oklahoma. On their reservation the Burbank and other oil fields were brought in, and a golden flood literally dropped into the blankets of the red men. They are today the wealthiest people per capita on the globe. If Alexander Pope had known about them he might easily have changed his famous line so as to read, 'Lo, the rich Indian.' Each one of the 2,229 surviving members of



THE CAPITAL OF INDIAN OILDOM, PAW HusKA, OKLA.

Oil development in the Osage Country during the past ten or twelve years has resulted in tremendous transformations. Pierce-Arrow cars now course over paved streets where Indian ponies once galloped over poor trails, and stately structures stand where picturesque tepees recently reared their slender poles.

the tribe had a minimum income of \$12,000 in 1923. One of them, Mary Elkins, received \$103,000 as her share that year. She happens to be the last surviving member of her family and inherited the rights of all her kin."† During the fiscal year ended June 30, 1925, the entire tribe drew \$29,422,000 from royalties and bonuses on oil and gas leases, making \$13,-200 per capita. Beginning with the first fiscal year (1905) in which output exceeded 100,000 bbls., the total yield from the Osage reservation to the end of June, 1926, approximated 325,000,000 bbls. of petroleum in addition to large quantities of natural gas from which much gasoline was

† Marcossion's "The Black Golconda," page 139. See also Chapter VII, "Oklahoma the Hub" or p. 10, *Saturday Evening Post*, April 12, 1924. Copyright by Curtis Publishing Co., but book published by Harper & Bros., 1924 (Price, \$4.00). This able writer, referring to the roll call of Osage tribe members at midnight on December 31, 1906, which established the "head-rights," wrote: "By this time the Osages had some inkling that their (rocky) land was valuable. They were eager to have as many head-rights in the family as possible. * * * One boy born at 11.50 on the last night of 1906 was named 'Johnny-on-the-spot.' A luckless girl baby who came into the world half an hour later was dubbed 'Mary-too-late.' Yet some people contend that the American Indian has no sense of humor." Read also "Early Days in Burbank," by Wm. Ash Waid, chief inspector, Osage Agency, in *Oil and Gas Journal*, November 27, 1924; poem, "The Osage," by Harry Walker, M. D., in "Souvenir of Pawhuska," by Mesdames B. Leahy, M. Leahy, I. C. Beaulieu, and K. Woodward (about 1911), copy of which the author procured through the courtesy of the banker, H. H. Brenner of Pawhuska, on his visit there, October, 1925.

recovered. To the end of 1925 these Indians had received over \$100,000,000 in the form of bonuses alone from the auction sales at Pawhuska besides royalties on production. Their total income to date from oil and gas (out of the 36 percent oil bearing part of their 1,500,000 acres) must be \$225,000,000 more or less.



INTERIOR OF LABORATORY, MELLON INSTITUTE

Industrial chemistry is the long suit of this well-endowed school (see text). Mankind in general is its beneficiary.

NEITHER POLITICS NOR NEPOTISM

Duties of Directors as Department Managers. When early in 1923 there came up before the Senate Subcommittee the question of why substantial salaries were paid to members of the directorates of gasoline producers, it implied that these men were overpaid for appearing merely at board meetings and that such "extravagance" was a potent factor in formulating price increases of motor fuel. Such accusations seem not to be supported by facts. In the case of the Standard of New Jersey, the aggregate salary of its executives made no more than one forty-second of a cent in the price of every gallon of petroleum products. According to its house organ,* the research work done by well-paid experts and their bettering of business practices have effected economies of greater good to the consumer than any benefits brought to the former. Apparently the word "director," as applied at least to Standard Oil executives, is a misnomer, for each member of the board manages a department which in itself is a business of big

* *The Lamp*, edited by Northrop Clarey.

proportions. Thus the director† responsible for marine interests is the head of the largest American shipbuilding concern. Moreover, he is in charge of the seventh largest steamship interest in the world, and his company is the only one flying the American flag to appear in Lloyd's Register among the forty largest steamship companies in the world.

Correct Conception of the Training and Responsibility of Directors. Instead, therefore, of being a person possessing much moneyed interest in the corporation, reviewing its affairs at board meetings, but taking no part in its actual administration, a director in any one of the leading American oil companies is a full-time specialist who not only directs but manages as well. He brings to bear upon a particular phase of the business the knowledge and ability which he has gained only through many years of arduous apprenticeship at a moderate salary. He has gained his high position in competition with many others; in truth, it may be said that the more successful oil companies manufacture their own executives. Four of one board began as junior clerks and three as manual laborers. One was a telegrapher, one an office boy, one a tank-wagon driver and one a salesman. Such men have no incentive of partiality, stock ownership, or personal or financial considerations for acting in behalf of commercial units other than his own, thus belying the common accusation that the several Standard Oil companies operate "in cahoots."

Why Oil Executives are Well Rewarded. They are paid salaries far in excess of the average earnings of capable men in order to prevent waste and extravagance. It is generally known that the Standard of New Jersey finds a use and market for every one of the hundreds of derivatives of petroleum; that even the odor of gasoline in its refineries has long ago vanished, converted into more gasoline, into other power, and into rare chemicals; that the business of this particular company, like that of many others, is not conducted by new or inexperienced employes, but that a lifetime of service is the usual thing and not the exception, and that in spite of the hazardous nature of the business, accidents and injuries are very few and the refineries run for years without serious fires.

High-minded Men Direct the Destiny of Oildom, and yet malicious minds are trying to blacken the reputation of big men in the business. As humans, they each have their drawbacks but not in degree greater than go with the leaders in other lines. Oil men are generous to a fault, fearless in doing their duty, and exceedingly popular with their employes since the latter believe sincerely in the former's sense of fair play. If the leaders were low-minded, and the rank and file disreputable fellows, how could such a fine character as the late Franklin Knight Lane, member of Wilson's war cabinet, have identified himself with the American petroleum industry? As it was, he gave up his great work for the Government and became vice-president of the Pan American Petroleum and Transport Company.

WHAT THE OIL MEN DID TO HELP WIN THE WAR

Cooperative Committee of Leading Oil Men. A stirring story is told by Isaac F. Marcossan in Chapter X of the "Black Golconda."* It relates to oil in the World War and pays particular tribute to the Cooperative Committee on Oil of the Advisory Commission of the Council of National Defense which played such a momentous part in tipping the scales of victory.

* Copyright by the Curtis Publishing Co., and published by Harper & Bros., New York
† John G. Pew, see pages 88-89.

A. C. Bedford was Chairman and E. C. Lufkin (then President of The Texas Co.) Vice-Chairman. Other members of the original committee were: Geo. S. Davison, E. L. Doheny, J. A. Guffey, H. C. James, John Markham, Jr., J. A. Moffett, Jr. (Secretary), Wm. Muir, H. F. Sinclair and J. W. Van Dyke.† In the spring of 1917 a shortage arose in the Eu-



REPRESENTATIVE OIL MEN, LARGELY PENNSYLVANIANS, PAYING TRIBUTE TO DRAKE AT TITUSVILLE ON THE 64TH ANNIVERSARY OF THE DISCOVERY

The two central figures are A. C. Bedford (who died September 21, 1925), and Calvin N. Payne (who died September 13, 1926, at the age of 81). Mr. Bedford distinguished himself during the World War in several ways, not the least being his prevention of profiteering in oil. At his death he was Oildom's acknowledged leader. Mr. Payne (the man with the glasses) entered the oil industry in 1866, and in 1885 began building up the Standard Oil Co.'s natural gas business. His son Christy is now head thereof.

—*The Oil and Gas Journal*

ropean supply of petroleum products, despite drastic conservation steps taken in Britain, France and Italy. Automobiles were allowed to operate only on urgent business.

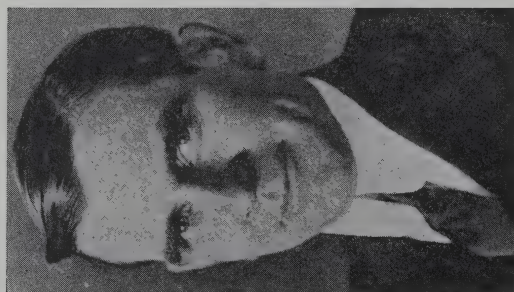
Oil Supplies Sold at a Sacrifice. "That the American oil industry met this emergency at great sacrifice is something the world now knows. * * * Perhaps the best summary of its part in the war was conveyed in a telegram of Capt. Paul Foley, U. S. N., to the National Petroleum War Service Committee (as the original committee was known after M. L. Requa was made chief of the Oil Division of the U. S. Fuel Administration): 'No military operation of the Allies on sea or land, under the sea or in the air, was ever interrupted by the lack of petroleum supplies.'"

"A vital change was worked in the American oil industry while we were at war. A new principle was brought into play—cooperation in place of competition for profits. * * * There is no more outstanding fact in the industrial history of the war period than the stabilization of prices for petroleum products at the time of an eager and crying demand for them. It was not only close coordination on the part of the oil industry with the Government, but equally close cooperation within the industry. *The oil business was the only great industrial enterprise dealing with a vital and necessary war product that the Government did not take over and fix prices.* This tells the whole story." * * * (Mr. M. referred to eight gasoline-less Sundays which helped to conserve huge supplies for over-sea shipments and which were instituted east of the Mississippi.)

A. P. I. an Aftermath of the War. "This inspiring story of cooperation did not end with peace. The experience born of war-time coordination was too valuable to lose and the machinery too useful to be scrapped. The industry had never before experienced even a semblance of organized national unity. The decision was therefore reached to perpetuate it in the form of the American Petroleum Institute organized in April, 1919, as a trade association dedicated to the service of the petroleum and allied activities. The Institute is not an association of oil companies because a company, as such, is not eligible for membership. It is an organization of oil men residing in the United States, Canada and Mexico."§

§ "Merchant Mariners Did Heroic Part in Great War," tells how Standard Oil fleet lost 10 steamers, *The Lamp*, August, 1919; read "Worked Together to Win World War" (referring to Standards and independents) in *Oil and Gas Journal*, June 14, 1923; "Lord Northcliffe and the Standard Oil Company," *The Lamp*, October, 1922; "Petroleum Institute Stands as Monument to A. C. Bedford," by V. B. Guthrie, *Nat'l Petroleum News*, September 23, 1925; "Mr. Bedford in the War," by Mark L. Requa before the Los Angeles meeting of the A. P. I., January, 1926, printed in *The Lamp*, February, 1926. Alfred Cotton Bedford was not quite 61 when called beyond on September 21, 1925. With his clean, correct living he should have lasted at least 10 years longer. On no other industrial leader devolved so much responsibility in winning the war. When the author saw him in May, 1925, Mr. Bedford betrayed no physical suffering; but he had really sacrificed himself already for his country. In an address before a section of the Am. Inst. of Min. Engrs., January 21, 1921, partly printed in *Mining & Metallurgy*, March, 1921, Ralph Arnold said: "When the stress of war demanded the best brains to handle that vital factor in the attainment of victory, petroleum, it was due to the efficient handling of our oil supply that we were enabled to take care of our own needs and a large part of our allies' as well. * * * The importance of Mr. Doheny's Mexican production during the war can not be overestimated; it furnished a large part of the fuel for the American and British navies. This most important asset to the American petroleum supply coming from a foreign country as the result of private enterprise and energy, should be sufficient proof of the wisdom of a definite policy."

† This committee was formed as the result of a call, March 22, 1917, on President Bedford of the Standard (N. J.) by B. M. Baruch, representing President Wilson. Members afterwards added: J. H. Barr, R. D. Benson, H. M. Blackmere, M. J. Byrne, M. Carey, A. P. Coombs, J. S. Cosden, W. P. Cowan, G. W. Crawford, B. G. Dawes, H. L. Doherty, J. C. Connell, W. S. Farish, H. E. Felton, F. Haskell, A. G. Maguire, V. H. Manning, S. Messer, J. E. O'Neill, J. Howard Pew, Edw. Prizer, R. W. Stewart, W. C. Teagle, and R. L. Welch.



A QUARTETTE OF CALIFORNIA OIL EXECUTIVES NATIONALLY KNOWN

From left to right—Lionel Barneson, son of Capt. John Barneson and brother of J. L. B., all three of whom built up the General Petroleum Co. recently merged with Standard of N. Y.; Paul Shoup, formerly president of Pacific Oil Co. which is now part of the new Standard Oil Co. of Calif.; F. C. Ripley, manager of the Chaslor-Canfield Midway Co.; I. W. Fuqua, president of the California Petroleum Corporation, whose chairman is Tom O'Donnell (page 79, Part One). It is flattering to Californians that of the four presidents of American Petroleum Institute, two have come from the Sunset State. (A likeness of the present A. P. I. head, E. W. Clark, of the Union Oil Co. of Calif., faces to the left, on page 112.) A seventh Californian, Geo. C. Jester, of Standard Oil, is the new president of the Am. Assn. of Petrol. Geologists.

—Los Angeles Oil Bulletin

"Cerro Azul came at critical hour;
Allies in arms needed fuel-oil power,

For coal couldn't make the enemy cower;
To effect his defeat 'twas oil for the fleet."

—O. H. R. in *Oil City Derrick*, May, 1925.

CHAPTER XIII—FINANCIAL SURVEY AND INVESTMENTS

"Organized industry means something different from a system aiming at quick and enormous profits. It is based on a definite theory of scientific effort whereby all the possibilities of a given resource are developed to their fullest degree so that waste ceases, the value of the labor is increased to the worker's benefit and the consumer receives the blessings of nature's dower at the lowest reasonable cost."—Victor Ross.

A BIRD'S-EYE VIEW OF THE BIG OIL BUSINESS

Financial Success Essential to Its Existence. Prospects of profits invariably induce corporations and individuals to venture into a business or to establish an entirely new industry. An operator's usual objective is long life and steady income which is quite consistent with the above idealistic expression quoted from "Evolution of the Oil Industry." Ford may represent the one extreme, but Drake certainly did not drill the first commercial oil well just for the fun of it. Rich reward would have been his had he but found a ready market for mineral oil. If the price of gasoline and behind it the price of crude petroleum be forced down to a profitless point for most producers and refiners, it may compel the closing of 250,000 wells yielding an average of one barrel or less per day. In order to maintain itself the industry must prosper. It must earn enough for capital return, current dividends, lean years and losses, as well as for the annual drilling of 25,000 new wells.

Living Costs Higher Without Help of Oil. Were it not for the numerous oil or gasoline-driven cars, trucks, tractors, irrigation pumps and other farm equipment, the cost of food would soar much higher since the farmers are becoming relatively fewer and farm labor is growing more expensive than in the past (page 20). Bonuses and royalties paid by oil companies have prevented farm abandonment during drought periods. Many isolated mines and small factories would be inoperative were it not for the several convenient and economical sources of power supplied by petroleum. Fishing vessels find their cruising radius greatly increased by gasoline power and thus are assured catches otherwise missed.

Good Roads Financed by Gasoline. Upwards of \$1,000,000,000 a year is being spent in the United States on road improvement. The country has 500,000 miles of paved or surface roads with 40,000 miles added annually. While this work is of economic value to the whole population, the direct benefits are enjoyed by motorists, and it is no more than just that they should contribute to the cost. As a matter of fact, automobile license fees and gasoline taxes provide 65 per cent of the enormous sum needed.* But the gasoline tax is paid directly by the petroleum industry which acts as a collector for Uncle Sam.

What Oil Has Done for Texas. From next to nothing in 1901, the oil industry of the "Lone Star State" has grown so extensively that there is now invested therein the huge sum of over \$1,250,000,000, according to President Farish of the American Petroleum Institute. In 25 years this business has brought into Texas probably more new money than all others combined. For bonuses and leases about \$70,000,000 was paid in 1925. Pay rolls of the oil companies approximate \$90,000,000 annually.

* Editorial in *The Philadelphia Record*, Aug. 26, 1926.

About 400,000 Texans depend directly upon petroleum for a living. Refineries near Beaumont and along the Houston ship canal run to stills fully 100,000 barrels more crude oil than is produced in the state. Of the total state taxes over 40 percent is derived from this industry.

California and Oklahoma Second and Third in Capital Outlay. If number of producing oil wells were the only criterion, then Oklahoma would have about five and one-half times as much as California invested in oil. But the Pacific coast state leads all in the cost per well and in refining capacity. It has, moreover, marine equipment naturally lacking in the inland state and marketing facilities fully three times as valuable owing to the much higher registration of motor vehicles. Oklahoma due to its numerous pools, has a pipe line mileage exceeding those of Texas and California combined. It leads all states in the investment in plants for recovering gasoline vapors from gas wells and oil wells. Altogether, the petroleum industry in California has absorbed probably more than \$1,000,000,000† and in Oklahoma almost that much.

Capital Expenditures Elsewhere.—Accurately to allocate the 10 to 11 billion dollars tied up in the oil business of the United States is quite a problem. Pennsylvania is still ahead of Oklahoma in the number of live wells, is third in pipe lines, and probably accounts for six or seven percent of the total investment. Kansas, fifth in number of wells, has taken about three percent. New Jersey, without any wells but with her big Bayonne and other refineries, many filling stations and marine equipment, has taken about the same percent of the total. Other important states in only approximate order are, Ohio, Illinois, New York, West Virginia, Wyoming; Indiana, Kentucky, Arkansas and Louisiana.* Capital invested in Canada's refining alone was \$50,600,000 in 1925;‡ total, including wells, probably more than \$100,000,000.

Financial Influence and Integrity Now Recognized. Outside of the Standard Oils the operators at times have been obliged to act almost as almoners. Even after the advent of the auto with its voracity for petroleum products, some of them had to beg for buyers of their securities in competition with stock sellers for fly-by-night affairs. Gradually the oil industry grew independent and largely financed itself out of its surplus funds. Particularly thrifty have been Gulf Oil, various Standards and The Texas Co. On July 2, 1926, the market value of the issued shares in all the Standard Oil companies approximated \$4,410,000,000 compared with little more than one-seventh as much in 1911 when the trust was dissolved. The high character of the men in charge, notably the late A. C. Bedford, has helped to beget confidence in the strength and stability of the companies themselves. Both bankers and the Federal Government have altered their attitude towards this big business. Oil men aid in directing the destiny of the biggest banks and they are often consulted on affairs of state.

Forms in Which Assets Are Found. Taking ten and one-half billions as the value of the physical resources of the entire industry at the middle of

† Equal to the assets of the Chase National Bank in New York or to half the sum now spent in the United States each year on amusements alone.

* See recent article in *The Oil & Gas Journal* by Chas. E. Bowles and C. O. Wilson, and in *Oil Trade* by H. J. Struth.

‡ Canadian Bureau of Statistics.

1926, it is found that this huge sum may be segregated as follows in round percentage figures:

Lands, leases, 300,000 producing wells and their equipment	43	150,000 tank cars, 10,000 bulk stations, 30,000 filling stations, 280,000 curb pumps, etc.	8
85,000 miles of trunk and gathering pipe lines with pump stations, and 500 tankers, etc., for crude oil.....	11	Steel tankinge, concrete reservoirs, etc., with 750,000,000 bbls. capacity containing 425,000,000 bbls. crude oil and 80,000,000 refined products, June 30, 1926.....	13
600 refineries with 2,000 crack-units; 1,100 natural gasoline plans	25		

The \$4,500,000,000 invested in the production branch of the business is but little less than the money in circulation, or about one-tenth of the value of the farms and farm buildings of the United States. The assets of the refining end (about \$2,500,000,000) approximate in value those of the U. S. Steel Corporation. In the relatively new business of condensing natural gasoline from its vapors, about \$225,000,000 represents the plant investment which amounts to half against as much as is yearly spent on college and university education.



—Standard Oil Bulletin.

AN OILDOM OFFICE BUILDING TOWERING ALOFT LIKE A DERRICK

Investments of the oil industry in buildings of all kinds must well exceed \$300,000,000 if consideration be given to the company homes of the oil field workers, the many pump-houses, factories and warehouses as well as the tall office structures on strategic sites. Here is shown the home of California's foremost oil company at San Francisco, seen from Nob Hill in 1923. In April, 1926, the new Standard Oil Co. of Calif., now owning the Pacific oil properties, became a \$600,000,000 corporation. In 1926 it earned over \$55,000,000 for dividends and surplus.

Who's Who in Oildom Ownership. There are various criteria for ranking the oil companies of our country as shown later in this chapter. Among these are capitalization, working capital income, inventories of oil, dividends and dividend rates and ratio of current assets to current liabilities. In regard to total resources inclusive of cash and securities, the leading operators occupy the order indicated below. The figures are based upon the companies' own reports. They may be taken to represent the percent of the total which pertains to each company, or units of practically 100 million dollars.

Standard Oil, N. J.....	13	Gulf Oil Corp.....	4	Tidewater Associated...	2.2
Standard Oil, Calif.....	5.4	The Texas Co.....	3.9	Pure Oil (Dawes).....	2.1
Standard Oil, N. Y.....	5.1	Sinclair Consol.....	3.3	Pan Am. P. & Transp..	1.9
Standard Oil, Ind.....	3.9	Shell Union.....	3.1		
	—	Empire Gas & Fuel....	2.8	Total, nine independents	25.6
Total, four Standards..	27.4	Union Oil of Calif.....	2.3		

Accordingly, 13 companies possess about 53 percent of the aggregate assets of the oil industry. The next five belong to the Standard group: Humble Oil and Refining, 1.6; Prairie Oil and Gas, 1.4; Vacuum Oil, 1.4; Prairie Pipe Line, 1.3; Atlantic Refining, 1.3; total 7 percent, or with the four major Standards, 34.7 percent for the nine. The succeeding seven are mixed: Phillips Petroleum, 1.25; General Petroleum (a California operator, now part of Standard of N. Y.), 1; Ohio Oil (a Standard), 1; Marland Oil, 1; Mid-Continent Petroleum (formerly Cosden & Co.), 0.8; Continental Oil (see map, page 116), 0.7; Skelly Oil, 0.6. From the foregoing it appears that 25 Standards and Independents possess about 71 percent of the total assets. The following five, each with assets of \$51,000,000 or more, bring the total (for 30 operators) up to 74 percent. California Petroleum, Producers & Refiners, Sun Oil, Standard of Ohio, and Transcontinental (Benedum & Trees interest).*

Brief Review of Recent Events. The year 1925, with over three-fourths of a billion barrels to its credit, astonished the connoisseurs who had looked upon 1923 as the peak year in crude oil production. The year 1926 is more like 1924, being without violent ups and downs. Output increased almost steadily, and in August had reached the same weekly rate that prevailed in August of 1925, practically 15 million barrels; estimated total for 1926, about 775 million bbls. Its value may yet equal that of 1920 when the domestic crude yield was hardly four-sevenths as great but worth \$1,360,000,000 at the well—eight percent more than in 1925. Considering the complete industry, 1926 is surpassing 1925 and apparently equalling 1920 in all-round prosperity. Net income for dividends and surplus of 65 oil and pipe line companies in 1925 approximates \$650,000,000; in 1926, probably more than \$700,000,000. Smackover, Ark., eclipsed all daily records of domestic pools with over 400,000 bbls. average during last week of May, 1925. Gasoline manufactured amounted to 260 million bbls. in 1925 (21½ percent more than in 1924) and 300 million bbls. in 1926, due to increased recovery through cracking. Exports of all forms of mineral oil exceeded \$500,000,000 during the year ended June 30, 1926. Stocks of all kinds were 550 million bbls.† on Sept. 30, 1925, unequaled before. Stocks of gasoline were 46 million bbls. in April, 1926, the highest ever. Domestic demand grows with increasing automobile consumption so that the industry did not fear overproduction in 1926 otherwise threatened by the deep development at Beaumont (Spindle Top, Texas, pages 40-41), the wide opening of the Panhandle (Texas) and Sunburst (Mont.) fields (pages 33 and 69), and new discoveries in Oklahoma and California. An epidemic of mergers, 1925-26, promoted practical conservation and financially strengthened those involved through better balancing.

* Adding the assets of the next ten, inclusive of South Penn, Pan American Western (Doheny), Union Tank Car, Standard of Kentucky, Barnsdall, and others, bring the grand total for 40 operators up to \$8,150,000,000, or say 77.5 percent of the total for the entire country. Ownership in oil can not be said to be as concentrated as in copper, motors, and iron and steel.

† Enough liquid to fill a lake two miles by 10 miles to an average depth of over 5 feet.

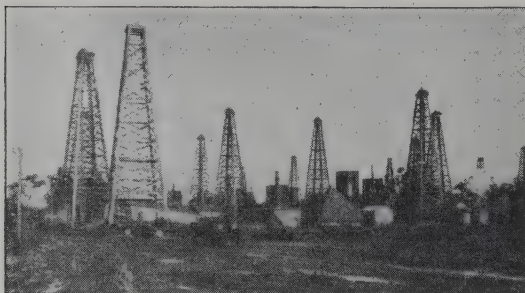
Financial Treasures versus Tragedies. Financial tragedies caused by pure promotions and mushroom operations have been considered elsewhere (pages 72, 79, 81, 102, 105 and following chapter). Tragedies and treasures relating to the legitimate or established industry are more frequent in the finding and producing than in the refining of petroleum. The great oil fires of the spring of 1926 in California and the Gulf region were tragic enough with their total loss of over thirty lives, but financially they were not of much consequence to such strong concerns as the Gulf, the Standard of California and the Union Oil. The public has heard much about these and other individual tragedies, but there is one mass tragedy about which very little has been told. According to E. W. Marland, the total returned through the sales of crude oil—\$7,500,000,000—was only 62½ per cent of the sum spent up to 1924 in finding, developing and producing mineral oil, the branch in which 99 percent of the operators are actively engaged (see under "LOSSES").

Other Branches Not Altogether Treasure Bearing. Tragedies arose in transportation during 1923 when it became cheaper to move California oil by tanker to the Atlantic seaboard than to pipe Mid-Continent petroleum thereto (pages 88 and 90). These tragedies were temporary, affected pipe line companies perhaps more severely than producers, and were ameliorated by the recent mergers. On the other hand, numerous refineries shut down in the interior of Texas and especially in Oklahoma prove that the more settled manufacturing end is neither uniformly nor universally prosperous. The overbuilding of small refineries began with the Ranger boom about 1918. Production of the different pools declined fast and portable refineries were not available. Some of the plants never paid for themselves. A few were luckily located at convenient points with regard to pools found later.†

Unlike Most Manufacturing and Coal Mining. To a certain extent petroleum partakes of the nature of other industries; it yields profits if fortunately located and economically operated.‡ But unlike ordinary business the crude oil industry can not at will multiply production to meet an increase in consumption either in a reasonable time or by a reasonable advance in price. Nothing but a long period of time and often only by doubling the price can production be stimulated enough to meet the demand. In other lines, such as coal mining and clothes making, output be reduced overnight to meet any decrease in demand. In the oil business production as a whole must go on regardless of a lessened demand or a diminished

† On financial phases of refining see: "The Profitable Refining of Petroleum" by H. L. Debar, *The Oil Weekly*, Jan. 21, 1922; "Preventable Losses in Oil Refining," The Calorizing Co., Oliver Bldg., Pittsburgh; "Distribution of Refining Costs" by R. D. Matthews, A. P. I. meeting, Ft. Worth, Dec., 1924; "The Refiner's Troubles," *Petroleum World*, December, 1925; "Refineries Spend \$100,000,000 Yearly for Supplies," H. J. Struth, *Oil Trade*, Feb., 1926; "Investments and Expenditures in Refining," C. O. Wilson, *Oil & Gas Journal*, Oct. 8, 1925, and "Strategy of Seaboard Refineries," L. M. Fanning, *idem.*, July 8, 1926.

‡ "But there is no certainty that even the company which possesses leases in established fields will prove profitable. Under these circumstances it is ridiculous to assume that mushroom promotions by men without experience in the oil industry, and whose talents lie rather in the direction of writing advertisements, can yield profits to those foolish enough to invest in them."—"The Evolution of the Oil Industry," Doubleday, Page & Co., \$1.50.



**UNNECESSARY NUMBER OF
WELLS SHORTENS LIFE,
INCREASES COST AND
REDUCES PROFITS.**

Offset or line drilling at Desdemona (in Eastland and Comanche Counties) brought wells only 50 feet apart before the new Texas laws made the limit 300 feet.

— Photo by the Author, 1919.

price. In fact, according to H. L. Doherty,* offset drilling must proceed even if there is a glut of oil on the market; else the lease of the land may be forfeited. The hazards in finding oil have never been exaggerated. They exceed 20 percent in the United States and 60 percent in Mexico, considering both pure wildcatting and drilling in proven fields.

OPERATING COSTS OF THE OIL INDUSTRY †

Annual Expenditures by Divisions. Since 1911 the Standard Oil Co. of N. J. has invested nearly \$800,000,000 in property apart from operating outlay. The annual capital outlay of the entire industry has increased from about 900 million dollars in 1922 to 1,200 millions in 1926. Adding the operating outlay would bring the aggregate annual expenditures of the industry to a total between \$3,000,000,000 and \$4,000,000,000. The distribution is below.

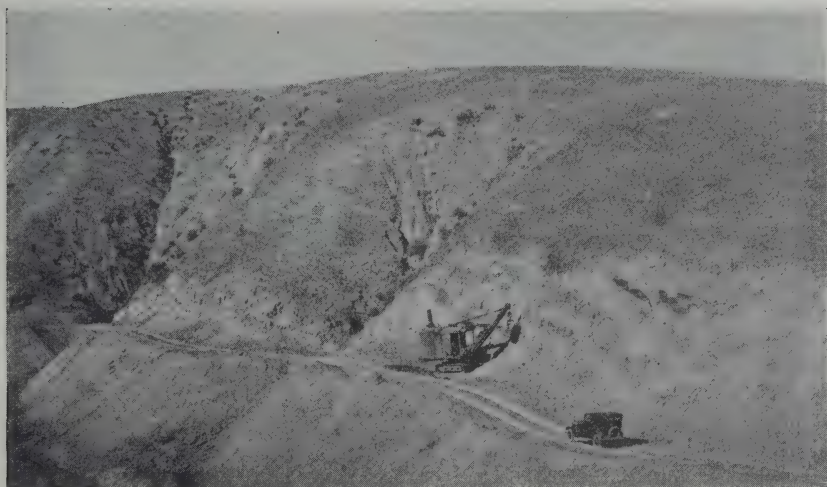
Divisions	Million Dols.	Divisions	Million Dols.
Exploring, leasing, etc.....	150—200	Gathering, storing, moving.....	300— 400
Drilling and equipping.....	500—650	Refining (excl. cost of oil).....	600— 750
Lifting or pumping.....	550—750	Marketing refined products.....	900—1250

Elements of Cost Comprehensive. Before the income tax law encouraged more accurate or complete accounting, many operators overlooked such elements as depletion of oil deposits and depreciation of equipment. Salaries and wages usually make the most important cost item. Equipment and supplies are exceedingly comprehensive and include nitro-glycerine for shooting wells, diamonds for core drilling and sulphuric acid for refining. Royalties are rarely paid in cash, generally in kind, and so may not appear on a cost sheet. Bonuses may prove a big factor in swelling the cost per barrel. Transportation affects both the material cost to the driller and producer and the crude oil cost to the refiner. Teaming and trucking run into high figures on heavy roads. Fuel or power is the principal item in

* Chairman of the Board, Cities Service Co., controlling Empire Gas & Fuel Co. To stabilize conditions, he claimed it would take \$1,000,000,000 to store a six months' supply of oil, figuring cost of oil, gathering and transportation charges, and the erection of tankage. This was over five years ago. His prophecy has come true. The two Americas then produced at the rate of 600 million bbls. per annum contrasted with nearly 940 million in 1926, despite the 25-million decrease in Mexico, making now 87 to 89 percent of the world rate.

† Current data on the cost of producing crude oil is hard to get. "Operators will seldom give out their costs."—Thomas Cox, Transactions of Am. Inst. Min. & Met. Engrs., 1923. "We need more exact data on costs so as to measure the profit element."—J. E. Pogue, *idem*.

operating pipe lines. Losses must be charged off whether caused by leakage, fire or theft. Interest, insurance and pension payments must not be ignored. Taxation takes forms only less multitudinous than in Mexico.*



—Standard Oil Bulletin.

ROAD BUILDING REQUIRES MUCH CAPITAL IN ROUGH COUNTRY

Particularly in Southern California must many of the wells be drilled in hilly regions as in the new Ventura (Avenue) field or in the Wheeler Ridge district (see page 64).

The combined direct and indirect taxes on gasoline, the oil industry, motor car manufacturers and their customers made about \$1,244,000,000 or over one-third the cost of the Federal Government in 1926.

Salaries and Wages Not Excessive. In 1919 the Census reported this item at \$168,000,000 in the crude oil and gas industry and at \$116,400,000 in refining, making a total of \$284,400,000 exclusive of the salaries and wages paid in the transportation of crude oil and in the distribution of refined products. Since then the production of crude has practically doubled, that of gasoline has quadrupled and costs have mounted considerably. The number of attendants at filling stations must have increased at least fourfold. The annual pay-rolls of Texas oil companies alone have been estimated at \$250,000,000. Those of all oil operators in every branch can not total much less than \$1,000,000,000 per annum. The rate of compensation may range from \$1,200 for some employes to \$125,000 for the highest salaried executive. The latter is not exorbitant considering the recipient's long training and responsibility and comparing it with the one-night winnings of a popular pugilist.†

* To the credit of the American Petroleum Institute, it may be stated that the oil industry has recently adopted a uniform system of accounting. Probably no other great American industry has advanced so far. See report of the committee, M. W. Mattison, chairman, made at the A. P. I. meeting held in Los Angeles, January, 1926. Among papers read before the Tulsa meeting, December, 1926, were "Accounting in Gasoline Manufacture," by G. F. Winters, of Phillips Petroleum Co., and "Marine Accounting," by F. S. Reitzel, of Sun Oil Co. See *Oil and Gas Journal*, December 16, 1926.

† At least one company has abolished the distinction between "daily wage" and "annual salary." See page 33, "Standard Oil Spirit," K. R. Kingsbury, Pres., Standard Oil Co. of California, May 30, 1923.

—*Rig and Reel Magazine.*

EQUIPMENT MUST BE REPLACED AFTER OIL FIELD FIRES

Equipment, Supplies and their Standardization. About \$250,000,000 is estimated as paid out yearly to the workers who manufacture materials, tools and machinery used in the oil business. The drilling and equipping of new wells require from 400 to 500 million dollars worth of supplies and equipment, 60 percent being for casing and pump rods.‡ Millions will be shortly saved through the adoption of uniform specifications and standards by the manufacturers. In January, 1926, a series of reports was made on standardization to the A. P. I. by 10 special committees, the national chairmen of which were J. Edgar Pew, A. H. Riney, A. B. Steen, Thomas Fleming, Jr., W. W. Fondren, H. J. Lockhart, J. F. Lucey, C. C. Scharpenberg, W. W. McLane, and G. M. Vanderveer.—Naturally, the makers of tubular goods and oil well supplies have prospered during late years, but when times have been bad they have been called on to extend large lines of credit to small producers and drilling contractors.

—*The Texaco Star.*

THE MANUFACTURING OF CONTAINERS ADDS TO MARKETING COSTS

Shown here is the cooperage, case and can factory of a leading independent at Port Arthur, Tex. The employees of this plant increased from 150 in 1909 to over 1,500 in 1925. Inclusive of steel drums, 10-gallon tins and wooden boxes, the annual call for all kinds of containers means now an expense over \$125,000,000 (see page 85).

‡ See *Oil Trade*, Aug., 1925, map by H. J. Struth showing distribution by states.

FUEL, POWER AND ELECTRIFICATION

Power and Fuel, Potent Cost Factors. In 1919 fuel and purchased power cost the crude mineral industry \$123,500,000. This item was surpassed by "Salaries and wages" (1,456 million dollars), "Supplies and materials" (528), "Royalties and rents" (175), and "Taxes" (141). It probably ranked fourth in 1925 in both the entire mineral industry and in its petroleum branch which alone is now spending from \$150,000,000 to \$200,000,000 yearly for fuel and power in producing, transporting and refining crude oil. Natural gas is the most economical and popular fuel for drilling; yet six million barrels of oil were probably consumed in 1925 for field purposes. Very little coal is used in drilling, but in 1919 the solid fuel used in refining was equivalent to 70 percent of the oil (23.6 million bbls.) burned therein (see *Oil Trade*, October, 1926, p. 65).^{*} The foremost refiner is prepared to burn either fuel according to which is the more economic. In 1927 the refinery of Standard Oil of Louisiana will use gas from the great Monroe field. Refining requires more heat but less mechanical power than oil production. Around Bradford, Pa., the gas engine has gained favor since it has cut the fuel cost to as little as 1 cent per foot. There the preferred power for pumping, however, is compressed air.

Electrification in Field and Refinery. Because of its lower cost and other advantages, electric power is coming into favor for drilling, pipe line pumping and refining. Savings by pumping electrically may vary from 3 to 8 cents a barrel over other methods.[†] One of the first uses of electricity was for rig lighting and arc-welding; the next was for pumping by the South Penn Oil Co. in 1905. A great obstacle to the widespread adoption of electric drive, particularly in rotary drilling, is the possibility of the failure of the supply, often with consequent disaster. Electrification has not advanced as rapidly here as abroad for two reasons: (1) Failure of the American companies to appreciate the possible economics; (2) an apparent disinclination of power companies to solicit oil field load, considering the returns not commensurate with the services demanded. American manufacturing showed 60 percent electrification in 1924. The oil industry is only 5 percent electrified compared with 1 percent of the railway mileage and 7.8 pr cent of the farms, according to Samuel Insull.

Electric Drilling Costs One-third that of Steam Drilling. Although speed, power and flexibility are inherent attributes of motor drive, the outstanding feature is operating economy. At 2 cents a kilowatt-hour for electricity and \$1.50 a barrel for fuel oil, the unit cost of electric drilling is but one-third that of drilling with steam. The development of differential gear for automatic control[‡] in well drilling has advanced the conservation of capital. By this application of electric power to rotary drilling one

^{*} According to *The Oil and Gas Journal*, July 1-27, 1927, page 47, U. S. refineries in 1925 consumed 6 million tons coal, 50 million bbls. fuel oil and sludge, and over 120 million M. ft.³ gas. Read "Greater Fuel Economy in Refineries," *idem*, 1-27-27, page 72.

[†] See page 107, Bulletin 224, Bureau of Mines, by H. C. George; also "The Engineering Achievements of the Westinghouse Electric & Mfg. Co. for 1925," by H. W. Cope, assistant director of engineering.

[‡] "Electrification in the Petroleum Industry" by H. E. Dralle, general engineer Westinghouse Electric & Mfg. Co., A. P. I. meeting, January, 1926, quoted in *Oil & Gas Journal*,

California company bored two 3,700-foot wells at an energy cost of 28.8 cents a foot where the power rate averaged 1½ cents; also four 3,600-foot wells at only 9½ cents a foot where the rate was not quite 1 cent a kilowatt-hour.‡

PRE-DEVELOPMENT COST

Geological Work Inexpensive But Essential. Ignoring geological science at the very beginning of an oil venture accounts for countless failures in this business. Organized search and the scientific selection of oil bearing structures are usually essential to financial success (footnote, p. 40). Admittedly, as in the Los Angeles basin, lucky strikes have been made for which the geologist can not claim credit. However, the two greatest light-oil fields in the Mid-Continent, Cushing and Powell, were discovered as results of deliberate search made by two distinguished geologists, R. E. Vandruff and F. Julius Fohs. Wideawake operators, like the Gulf, Marland, Pure, Union and Vacuum companies, do not aim to spare expense by neglecting geological work. The cost is trivial compared with the tremendous returns. The Vandruffs received but \$800,000 for their services although the 300 million barrels of light oil produced to date from the Cushing field would be worth \$600,000,000 at only \$2.00 a barrel.*

Outlay for Leasing Often Large. If the geologist has reported favorably, the actual leasing is done by a member of the land department. The cost of a leasehold may be either nominal or enormous according to the bonus price. In some cases the land owner asks for royalty only, provided the development is not deferred. Usually, nowadays, he gets both bonus and rental. If an operator locates good oil land in the absence of competition a leasehold may cost very little. He may even procure the fee title for a farthing if he is foresighted like E. L. Doheny in Mexico; but this is the exception. During the Beaumont boom, 1901-1902, over \$100,000 was reported paid for a lease on a single acre at Spindle Top where a second boom is now in progress. This was ridiculously high in view of the low price of 5 cents of which Gulf Coast crude sold at one time. Among big bonuses given for any sizeable tract may be mentioned the \$1,990,000 paid by the Midland Oil Co. for the privilege of drilling 16 3,000-foot wells on 160 acres of the Burbank field in Osage County, Oklahoma (equivalent to \$12,444 an acre). Cosden paid but \$35,000 less for the lease on a nearby quarter section, at the same Osage auction sale in March, 1924.

‡ "Hild Electric Drive" by Thos. Fleming, Jr., vice-president, Oil Well Supply Co., idem.: Gulf Production Co., at Hull, Gulf Coast field, during 1924-1925 drilled five wells 3,000 to 4,000 feet deep at an average of 20.4 cents a foot for power compared with an average of 55.5 cents a foot if bored with steam drive.

The world's deepest hole bored with an electrically driven rotary is the No. 96 of the Chanslor-Canfield Midway Oil Co. in the Brea-Olinda or Fullerton field near Los Angeles. It was 8,046 feet deep in September, 1926, or 455 feet deeper than E. J. Miley's No. 6 at Athens, Calif. (7,591 feet), which holds the *steam* rotary record or the Peoples Gas Co.'s Ligonier (Pa.) well which has the record (7,756 feet) for any hole drilled with standard or cable tools—*Oil & Gas Journal*, July 22 and August 12, Philadelphia News Bureau, September 7, *Oil Trade*, October, 1926, p. 46.

* See 2-page story about the Author's former associates in the *Scientific American Supplement* of June 9, 1917. See also pages 42 and 78 and chapter XII.

Ignorance and Interloping Boost Bonus Costs. In regard to bonuses offered for Osage leases most regrettable lack of information was shown.† While some of the bidders had availed themselves of geological guidance, many tracts with favorable oil structures were neglected and large bonuses paid for others that may never pay out; all the more unfortunate because Osage leases require early drilling. Promoters and irresponsible speculators often compete with established operators, particularly in new fields where excitement runs high. These interlopers greatly increase the amounts that must be paid for leases whether on proved or wildcat land. While not fictitious, *per se*, such fancy prices make it hard for the Treasury Department to adopt sales values in actual transactions as a method of limitation for depletion deductions on income tax returns.

Capital Conservation Through Core Drilling. The average driller is "at sea" in trying to keep a well log comparable in accuracy with that of a vessel on a voyage. It is a shameful fact that the geological records of nearly 90 percent of the wildcat wells drilled in the United States are practically worthless. In the entire country 5,583 dry holes of all kinds, including wildcats, were put down in 1923, one of them costing \$500,000 to complete. Considering the cost of only 2,500 unreliable tests as the annual average at \$40,000 each would mean \$100,000,000 thrown away each year. The same number of holes bored with core drills to an average depth of 3,300 feet at a cost of only half that huge sum would not only save \$50,000,000 a year but would supply absolutely dependable records of the geological formations (pages 47-49).

Cost of Core Drill Exploration. Such substantial saving is made possible largely because so little and such light casing is required in core drilling. The elimination of cumbersome casing and of the attendant labor has conserved from \$90,000 to \$140,000 on 5,000-foot tests bored with core drills in California. Coring at intervals only, as practiced in California and the Gulf Coast (pages 44-45), runs the cost per foot of core as high as \$50. Nevertheless it is worth while since it insures production which might otherwise be missed.* Continuous coring with black diamonds is rather reasonable although their price has increased three-fold in thirty years, being now \$110 to \$150 a carat. The consumption of carbons varies greatly, even in oil bearing strata—from 5 cents to 50 cents a foot. The total per foot, allowing for depreciation, runs from \$1 to \$7 according to depth, power, need for casing, nature of formations, etc.

† David White, introduction to Bulletin 686, U. S. Geological Survey. The Osage Reservation is financially important because, even at this later date: (1) It contains much unleased oil land; (2) anticlines and domes are numerous and drilling indicates that most of them yield oil; (3) productivity of developed areas is high and sustained; (4) oil is of paraffin grade, yielding 50 percent gasoline; (5) pipe lines and refineries are at hand; (6) the Office of Indian Affairs, which administers the land, offers leases at auctions on advertised dates.

* "The first well to produce oil in the Dominguez field was the 'Callender' of the Union Oil Company of California. Had no core been taken the presence of oil might have been discovered only accidentally or it might have entirely escaped detection, as it actually did in two other wells drilled before in that locality."—R. P. McLaughlin, Houston meeting, American Association of Petroleum Geologists, 1924. Late in 1925 some 60 diamond drills were operating in one part of Oklahoma, according to J. L. Dwyer in the *Oil & Gas Journal*, November 19. See *idem.*, April 8, 1926, on cost of equipment and operating; also *Oil Trade*, January, 1924, p. 46. On the value of drill cores to the operator, see Press Bulletin 2060 of the Bureau of Mines describing Bulletin 243 by F. A. Edson.



**PORTABLE RIGS AND ENGINES
PROVE ECONOMICAL FOR
SHALLOW DRILLING**

This is a Star cable machine intended for 1,000-foot development in the 2-5 District, Stephens Co., Okla., early in 1920 by the author and his Los Angeles associates.

COST OF DRILLING AND EQUIPPING WELLS *

Equipment and Supplies Variable Factors. Portable steel derricks are the most economical and durable. Delivered and erected near railways they cost from \$1,000 to \$4,000, but each being serviceable for 40 or 50 wells, the cost per well may be reduced to \$100 in rare cases. A portable cable drilling outfit, good for 1,500 feet, may cost only \$3,000; the ordinary cable or standard tools with boiler and engine, good for 2,000 to 4,500 feet, from \$4,000 to \$16,000; a complete rotary with drill pipe and steam power plant, for 4,000 to 5,000 feet, from \$30,000 to \$40,000. According to the number of strings and their weight or size, the casing cost may vary from \$5,000 for a 2,000-foot well to \$16,500 for a 3,000-foot well (in Burbank field); or it may be as low as \$500 for 500-feet (in North Central Texas) or as high as \$7,700 for a rotary drilled well 3,400 feet deep (in the Gulf Coast fields). If the drilling is not, as usual, done by contract the drilling tools may be rented at \$10 per day for small cable outfit to \$100 for complete rotary (without boiler). The cost of pumping equipment per well depends upon the depth and the power used. The principal items of equipment for drilling and operating the world's second deepest rotary hole (7,591 feet deep)† were:

Casing	\$28,526	Use of rotary, 230 days...	\$23,000	Steel tanks	\$3,866
Steam plant ...	9,917	Production equipment ...	4,335	Pipe lines	3,155
Wire lines	5,187	Rig and derrick.....	4,153	Gas traps, etc...	1,961

making a total of \$84,100 or almost half the total cost of \$170,424.

Wages of Oil Field Workers. In 1919, when production was at half the present rate, the total wages paid in the crude oil industry was \$134,500,000 compared with likely no less than \$300,000,000 in 1925. Wage rates have dropped very little since 1920 for which year the following statistics were

* "Drilling costs are composed of elements which vary widely with the depth of the well and the difficulties encountered. The principal items are: (1) Drilling rig, (2) drilling contract, (3) casing, (4) fuel and water, (5) pumping equipment and (6) miscellaneous labor and supplies."—"Business of Oil Production," by Johnson, Huntley & Somers, John Wiley & Sons, 1922. This book, in Chap. XIV, details the cost of drilling in 9 fields during 1921.

The cost factors are more completely analyzed by Thomas Cox in "Trans. of the Am. Inst. Min. & Met. Engrs.," vol. LXIX, page 1133.

† See *The Oil Weekly*, February 12, 1926.

published by the United States Department of Labor showing the average number of hours per week and the average earnings per hour. Earnings per day were calculated by the author, based upon a 12-hour day for drillers and tool dressers since the 8-hour day was not adopted in California before the summer of 1925.

Occupations	No. of establishments	No. of employees	Hours per week	Earnings per hour	Earnings per day
Drillers	54	2,575	73.6	\$1.140	\$13.68
Tool dressers	49	1,894	78.6	.934	11.21
Rig builders	19	432	55.2	.919	8.27
Machinists	25	274	55.6	.890	8.01
Drillers' helpers, etc.....	32	2,731	59.7	.683	6.15
Firemen	29	1,128	57.7	.651	5.86
Roustabouts, etc.	56	11,913	57.7	.589	5.20

Unit Cost Varies with Depth. To illustrate the increase in cost with depth the following table has been taken from the transactions of the American Institute of Mining and Metallurgical Engineers.† It relates to cable drilling in Osage County, Okla., during 1922.

Developed Fields			Untested Territory		
Depth	Per well	Per foot	Depth	Per well	Per foot
1,000	\$5,000	\$5	1,750	\$21,000	\$12
1,500	9,000	6	2,000	26,000	13
2,000	14,000	7	2,500	37,500	15
3,000	33,000	11	3,750	75,000	20

The depth is doubtlessly the greatest factor in bringing up the average cost of drilling wells in the United States from \$3,200 in 1912, to fully \$25,000 in 1926. The electrically drilled world's deepest hole cost only \$25 per foot.

Geographic Range in Cost. It is a far cry from the drilling of a 60-foot hole in Pennsylvania 67 years ago to that of a 5,000-foot wildcat in the wilderness of tropical Colombia in the year 1924. The former may have cost less than \$500 using a spring pole; the latter fully \$500,000, using a standard rig. Between these two extremes may be found varied costs of development due to the different geological conditions or to the use of the right or the wrong type of tools.

† Thomas Cox, page 1131, vol. LXIX, February meeting, 1923.



—Photo by the Author.

FLOOR OF A ROTARY RIG IN TEXAS

Field	Depth feet	Drilling system	Contract per foot	Cost of casing	Complete cost
Greenwood Co., Kans.....	2,200	Cable	\$1.75	\$9,000	\$22,000
Cowley Co., Kans.....	2,800	Cable	2.75	18,000	30,000
Burbank, Okla.....	3,000	Cable	3.50	21,500	43,200
Tonkawa (deep), Okla.....	4,200	Rotary	9.00	18,200	68,000
Salt Creek, Wyo.....	2,640	Cable	3.50	9,800	25,800
Powell, E. Cent., Tex.....	2,950	Rotary	3.00	4,200	22,100
Bristow, Okla.....	3,000	Cable	2.50	12,600	25,000
Wewoka, Okla.....	3,050	Cable	4.00	19,000	38,000
Athens, Calif.....	7,591	Rotary	....	28,500	170,400

If the well is successful there is a salvage to be realized from \$2,000 in Greenwood County to \$13,200 in the Burbank field. In general the rotary is more expensive than the cable system for shallow wells and very deep ones.

COST OF PRODUCING CRUDE OIL

Six Sources of Production Expense. According to the Bureau of Mines * the operating costs in the producing branch may be grouped under six heads: (1) *Overhead or general expense*, including salaries of clerks and executives, legal expense, insurance, rent, taxes, etc.; (2) *general development expense*, covering land and leasing, chemical, engineering, geological and scouting departments; (3) *development expense*, embracing bonus payments, drilling costs and outlay for new production; (4) other or *miscellaneous field expense* as for oil field camps, road repairs, etc.; (5) *lifting expense*, including cost of labor and materials for operating flowing wells and for pumping, charges for repairs and depreciation of equipment, and cost of delivering oil from wells to field tanks; (6) *treating expense*, taking in the outlay for maintaining and operating dehydration plants for emulsified oils and steaming plants for chilled or viscous oils.

Costs Vary Greatly in Getting Out Oil. Among the factors that influence the lifting cost are such special conditions as depth and character of the sands, quantity and character of the oil, pressure of the gas, volume of the water, and the topography around the wells. On any one property the lifting cost may make up from 20 to 90 percent of the ultimate cost of production. It may be even less than 20 percent in the case of flowing wells as until recently in the Salt Creek field. The table herewith, reproduced in part from "The Oil Industry's Answer," shows an interesting geographic range in *lifting cost alone* for the first half of 1921, being exclusive of taxes, overhead, development, depletion and depreciation charges.

No. of wells	Location: Field and State	Bbls. per well per day	Cost per barrell	Average depth	Lifting method	Power used
137	Tionesta, Pa.....	.05	\$4.86	1,200-1,400	Power	Gas engine
74	Beaver Co., Pa.....	.17	3.03	1,000-1,600	Beam	Gas engine
61	Monongalia Co., W. Va..	.74	2.20	2,163	Power	Gas engine
70	Kane Co., Pa.....	2.9	1.70	2,000	Beam	Gas engine
36	Bradford, Pa.....	1.03	1.14	2,000-2,100	Beam	Gas engine
128	Augusta, Kans.....	13.3	.95	1,700-2,400	Beam	Electric motor
59	Washington Co., Okla...	.43	.74	470-1,350	Power	Gas engine
268	El Dorado, Kans.....	16.6	.69	750-2,400	Beam	Electric motor
26	Glenn pool, Okla.....	4.1	.52	1,640	Power	Gas engine
65	Washington Co., Ohio...	.78	.45	300-1,200	Power	Gas engine
211	Coalinga, Calif.....	34.7	.44	2,500-3,900	Beam	Gas engine
6	Wichita Co., Tex.....	32.7	.41	1,666	Power	Steam engine
172	Osage Co., Okla.....	5.7	.36	1,600-2,200	Power	Gas engine
21	Goose Creek, Tex.....	77.8	.20	3,040	Beam	Electric motor
65	Salt Creek, Wyo.....	106.	.04	1,700	Flowing	None

Total Cost of Producing Petroleum. A committee of the Nat'l Petroleum

* H. C. George (head of Petroleum Engineering, Univ. of Okla.) in *The Oil Weekly*, October 27, 1923. See Bull. 158, Bur. of Mines, "Cost Accounting for Producers."

Marketers' Association investigated the cost of crude oil produced from January 1, 1921, to June 30, 1923.* Its report did not show how the cost factors were grouped and apparently the total cost given did not cover the overhead, general and miscellaneous expense as well as depreciation distributed between drilling and lifting. Including these items, the total for the 2½ years would probably surpass the sum of almost \$3,000,000,000 or \$2.17 per barrel according to the table below.

SUMMARY SHOWING ELEMENTS OF COST IN PRODUCING 1,360,000,000 BARRELS OF OIL

Cost of drilling (462¾—542—323¼) millions.....	\$1,328,000,000
Cost of lifting 1,360 million bbls. at 50 cents a bbl.....	680,000,000
Bonuses (Osage 42 millions; others, at \$10 an acre).....	353,000,000
Rentals (198 millions, 1921; 20., 1922; 210, 1923).....	615,000,000
Total cost, period from Jan. 1, 1921, to June 30, 1923.....	\$2,976,000,000

Because of the advantageous location of the new California fields and the very large wells found, crude oil of a quality but little inferior to that of the Mid-Continent was profitably produced and marketed in 1923 at a figure which represented hardly half the cost of producing oil in the Mid-Continent fields.†

Cost Varies Inversely With Yield. The following figures illustrate the fact that *the smaller the well, the greater the unit costs*. They relate to the year 1921, the yield per well per day includes royalty oil, but the costs pertain only to the working interest of companies operating in Osage County.

Number of wells	Output per well per day	Production costs per barrel			of net production	
		Lifting	Overhead	General	Depreciation	Total
619	6.58	\$0.45	\$0.16	\$0.12	\$0.29	\$1.02
151	4.57	.51	.15	.19	.26	1.11
1,932	3.88	.51	.17	.19	.30	1.17
1,284	2.42	.70	.20	.31	.44	1.65
877	1.79	.90	.23	.42	.58	2.13
528	1.31	1.08	.27	.57	.74	2.66

Preventable Increase in Production Cost. The cost rises concurrently with the increase in the quantity of unrecoverable oil when the lifting energy of the natural gas in an oil well has been dissipated. Where there is little opposition to the escape of gas from an underground sand, the oil is readily left behind. Experimentation determines what rate of production is most efficient. In Eastland County, Tex., during five months of 1919 a well was allowed to waste its gas into the air in the hope that the well would begin yielding oil. When it finally came in the flow was reported at only 50 bbls. daily. Had it been closed in and another well been drilled lower down on the structure, so as to strike oil instead of gas (page 24), a gusher of 500 to 5,000 bbls. might have resulted, and the natural flow would have persisted much longer, thus avoiding pumping expenses during the interim.*

High Bonuses Hoist the Cost of Crude. Herewith is shown the bonus

* "Producing Cost and Market Value of Oil," by C. C. Osborn, Economist, Maryland Oil Co., in *The Oil and Gas Journal*, July 31, 1924. See *Oil Weekly*, February 19, 1926.

† See "Vital Needs of Oil Conservation," by E. W. Marland in *Mining and Oil Bulletin*, November, 1923, page 962.

* See Lewis and McMurray's "Underground Wastes in Oil and Gas Fields and Methods of Prevention," Bureau of Mines, 1916; also G. W. Stocking's "The Oil Industry and the Competitive System," Houghton, Mifflin Co., Boston, 1925, \$3.50. and page 69. "Public Hearings, May 27, 1926, Federal Oil Conservation Board."

price per barrel of oil recovered from the Burbank field within Osage County up to December 1, 1924, by the 10 operators leading in production:

Names of companies	No. of wells	Bonus paid for leases	Thousand barrels	Bonus per bbl.
Carter Oil Co. (Standard).....	219	\$4,029,100	10,321	\$0.39
Sinclair Oil & Gas Co.....	145	3,797,300	7,820	.49
Gypsy Oil Co. (Gulf Oil Corp.).....	197	9,058,200	15,022	.63
Phillips Petrol.-Skelly Oil.....	174	10,027,100	11,877	.85
Prairie Oil & Gas (Standard).....	106	4,935,000	5,598	.88
Phillips Petroleum Co.....	111	4,453,000	4,517	.98
Mid-Kansas Oil & Gas Co.....	39	2,775,000	1,822	1.52
Cosden (now Mid-Continent).....	105	4,981,000	2,672	1.87
Skelly Oil Co.....	22	1,340,000	562	2.39
Midland Oil Co. (Doherty).....	37	3,631,000	703	5.16

The total for 28 producers made \$52,241,000 in bonuses and \$76,312,097 in oil. If the rest of Osage County be included the bonuses paid to the middle of 1925 aggregated nearly \$95,000,000. The average for almost 630,000 acres leased to July 1, 1925, was \$150 per acre or about 40 cents per barrel output. The largest paid at any one auction was \$14,193,800 on March 18-19, 1924.*

MARGIN BETWEEN COST AND MARKET VALUE

High Bonuses Eliminate Profit Margin. In regard to the bonuses bid at the Osage sales one authority claims: (1) They are too high for the price of oil and give the Government wards almost the entire returns; (2) if such bonuses and high royalties are necessary to get production, the price of crude must advance fully \$1 a barrel in order that the producer may obtain a fair return on his investment; (3) under normal operations the price of \$1.35 for Mid-Continent crude barely permits the earning of operating and investment costs, leaving no average surplus for dividends and interest; (4) prices of gasoline and other products are not high enough to permit the independent refiner to make any returns on his costs and investments.**

Cost Determines Price—Not True or Petroleum. Unlike ordinary commodities, the price of neither crude nor refined oil bears a systematic relation to the cost of production. In reaching the real marginal or governing cost of production the crude producer must consider certain elements not usually taken into account by the consumer. The operator must allow for the depletion of the natural resources, on a cost basis often made up mostly of the bonus outlay, say 5 to 50 percent of the true cost. He must also consider dry holes and abandonments and the rentals of undeveloped acreage. If the law of marginal cost is to prevail, then Pennsylvania crude should command no less than \$5 whereas, in August, 1926, it brought but \$3.40 a barrel (page 75 and table under "Cost of Producing Crude Oil"). Many small producers of this grade are losing money.†

* "In the producing department competition has resulted in the payment of bonuses for promising acreage that a few years ago would have been undreamed of figures."—Pres. W. C. Teagle of the Standard (N. J.) in *The Lamp*, March, 1923. See *Rig and Reel*, April, 1924; *Sat. Eve. Post*, April 12, 1924; *The Oil & Gas Journal*, December 14, 1922; July 10, 1924; March 12, 1925.

** "Relation of Bonuses and Costs to Prices of Crude and Its Products," by Thomas Cox, Am. Inst. Min. Engrs., N. Y., February, 1923.

† Sir Robert Waley-Cohen in his "Economics of the Oil Industry," an address before the Empire Exhibition at London, identified the marginal cost with "the cost of production of that part of the annual output which is wrested with most difficulty from the lap of nature." See *The Oil & Gas Journal*, April 5, 1923, May 22 and 29, July 3, 10 and 31, 1924; also *The Wall St. Journal*, December 2, 1924.

Worth at the Well, 1923-1924. Arranged in the order of the average unit value for each of the 12 leading oil states, according to the Bureau of Mines, these in 1923 and 1924, together with the total in 1924, were as follows:

State	Average per bbl.		Total, 1924 (millions)
	1923	1924	
Pennsylvania	\$3.33	\$3.61	\$27
West Virginia	3.27	3.52	20.8
Ohio	2.41	2.52	17.2
Kentucky	1.97	1.97	14.6
Illinois	1.87	1.76	14.2
Oklahoma	1.74	1.57	272.5
Kansas	1.63	1.54	44.4
Texas, all	1.48	1.52	204
Texas, Gulf	1.39	1.56	40.6
Louisiana	1.47	1.44	30.3
Wyoming	1.09	1.23	48.6
California	0.92	1.20	275
Arkansas	0.69	0.94	43.1
All states	1.34	1.43	1,022.7

For 1925 the average had increased 17.4 percent to \$1.68 a bbl. and the total 25.6 percent to \$1,285,000,000. The only value below \$1 was in Arkansas where the overproduction of heavy oil at Smackover caused a drop to an average of 89 cents.

Cost Versus Market Value. The Nat'l Marketers Association has worked out a balance sheet for the crude oil business showing a deficit almost \$1,100,000,000 for the 2½ years ended June 30, 1923. As already indicated, to produce the 1,360 million barrels of oil cost \$3,000,000,000, or \$2.17 a barrel, which seems conservative. With the weighted average market value only \$1.39, the loss amounted to \$0.78 a barrel. The total value of \$1,892,900,000 for this period was obtained by deducting only \$270,400,000 for an average ⅓ royalty oil from the sum of the following values, expressed in millions: 1921, \$811.3; 1922, \$884.3; first half of 1923, \$467.7. The average of \$1.39 corresponds closely to that of \$1.34 for the full year 1923, as shown in the preceding table.*

Good Prices Encourage Conservation. Living prices for the crude producer not only affects the prosperity of his business but also has a powerful bearing upon oil reserves. Mineral resources, notably copper and iron, vary in commercial volume directly with the price and inversely with the cost of mining and reduction. Pogue shows that the reserves of petroleum under a \$2 price is relatively small but under increasing price increment would become very large. It is the law of supply and demand—a fundamental aspect thereof as applied to natural resources. Under current price level it is practicable to extract only 15 to 25 percent of the oil content of sands. When justified by higher prices, much of the remaining oil may be reclaimed by the more costly but efficient methods of flooding, mining, pressure, soda-solution, and vacuum.†

Oversupply With Prices Subnormal. As narrated on pages 72-74, tragic consequences have resulted to operators who confine their activities to crude production. To them, tragedies and not treasures will rule as the return until the national output of petroleum falls off from 15 to 20 percent. Such a reduction would be found quite feasible by withdrawing oil from direct competition with commonplace coal, extending the cracking process for in-

* See article by C. C. Osborn, Marland Oil Co., *Oil & Gas Journal*, July 31, 1924, page 152.

† "Production of Petroleum in 1924," *Am. Inst. of Min. Engrs.*, page 51.

creased gasoline recovery and multiplying the mileage from a gallon of motor fuel. This would bring a price improvement without a concurrent swelling of total cost to the consumer. It would create a margin of profit for many small operators who can not continue to produce at a loss much needed light oil from 250,000 wells. Normal prices should be about \$1 above the recent quotations of August-September, 1926.

VALUATION OF OIL PROPERTIES *

Definition of Values. Ordinarily an oil property has two values: (1) Value in exchange and (2) value in use. The former means the sales value which may vary from time to time, particularly during and after boom days and other competitive periods. The value in use is synonymous with its productive value or the present value of its future net income. It is the capital which the future income can repay after allowing for interest and risk. Since the soil and the improvements generally go with the land, proper accounting recognizes three elements pertaining to the feehold value of oil land, namely the petroleum reserves, the physical equipment, and the advantages of the land for building or farming.

Variations in Value. The term "oil property" may mean the mere right to drill on undeveloped wildcat acreage or the actual ownership in fee of a fully drilled tract of oil land. It may refer to the royalty interest in whole or in part, or to the working interest. The value of the working interest, which is the "property" usually bargained for, may vary widely according to the use for which it is intended. The fraudulent stock promoter wants to inflate the value for promotion purposes; the lease speculator wants to sell the "property" at a good price even if it cost him next to nothing; the oil producer has to run risks in developing, and if oil is found has to pay for the cost of production, so is opposed to a big bonus or an outrageous royalty; the refiner or the pipe line owner may want the oil reserves so as to keep his plant or his pipe lines supplied when other sources become exhausted.

Development, Equipment, Appreciation. For income purposes oil land has no value unless developed and equipped. The cost of drilling should be charged off as expense in the course of development or as capital to be returned before the oil reserves are depleted. The cost of physical property, such as casing, engines and boilers, should be charged to capital. As the equipment wears out, depreciation should be deducted annually according to its estimated life if shorter than the life of the oil reserves.† Such property may have salvage value after all the recoverable oil has been

* Abstracted in part from Robt. W. Brown's "Valuation of Oil & Gas Lands," McGraw-Hill Co., 370 Seventh Ave., N. Y., 1924. His valuation purposes are: Guidance in Operation, Basis for Merger, Basis for Capitalization, Basis for Loan, Taxation, and Basis for Sale or Purchase. Principles expressed by the Appraisal Committee of the Indep. Oil Producers Agency consisting of Messrs. Requa, Quigg and Haseltine, were: (1) Each property will ultimately yield a certain quantity of oil; (2) in the production thereof certain sums will be spent; (3) a certain amount of money will be received for the oil; (4) net receipts will be the gross less the cost of development and production; (5) the present value must be an amount which invested will return the buyer the original purchase price plus 8 percent during the producing life. See "Valuation of Oil Properties for All Purposes," by J. L. Darnell, Fort Worth meeting, A. P. I., 1924.

† See revised "Manual for the Oil & Gas Industry," by Fay, Reinholt, etc., U. S. Treasury Dept., 1921, pages 59-71 and pages 14-16; also "Depreciation," by A. R. Paton, *Petroleum World*, July, 1925.

removed. The cost of unsuccessful tests should be charged off as a loss. If a discovery of valuable reserves results from drilling, the land will usually be worth more than the purchase price (or the bonus, if the land is merely leased). This additional value or "appreciation" may be found by appraisal and should be entered in a separate account. In determining the *value to the producer*, the appraiser, unlike a bookkeeper, balances expenditures against receipts on *business of the future*.

Methods of Valuation. Various methods have been developed, some for accuracy. The need for accuracy is greater for commercial than for taxation purposes. There are 5 general methods: (1) The "analytical appraisal" or present value method; (2) arbitrary methods in which "rule-of-thumb" formulae are applied; (3) the sales method in which sales and transfers are analyzed and compared with respect to the property involved; (4) the accounting method, in which values are determined from an analysis of balance sheets and profit and loss statements; (5) the comparative method, in which comparison is made between different properties or types of properties, as in the determination of value of a royalty interest from a predetermined value of the working interest.

Present Value Method. This engineering method is confined to the determination of the productive value or the present worth of the future expected net income. Two steps are involved: (1) Correct estimation of the elements of value—oil reserves, rate of extraction, price of oil, cost of producing, and proper discount factor; (2) mathematical calculations which, in regard to oil valuations, involve a separate discounting to obtain the present value of each year's output since the rate of production can not be kept uniform as in the case of coal mining, but diminishes annually from a property fully developed. If a property is but partly developed that part should be subdivided into "flush" and "settled" productions provided the old and new wells are not intermingled.‡

Specific values vary greatly according to the quality of the oil, the cost of producing, distance from market and expected life. Natural conditions differ even in the same field, so that it is inadvisable to buy production of one property based entirely upon the price paid for that of a neighboring one. Although the barrel-day method has been condemned,* there are tabulated below data on a number of actual sales reduced to the barrel-day basis for purpose of comparison.

Field and State	Month and year	Daily yield	Total cost	Price per bbl.	Name of buyer
Lost Hills, Calif.....	Sept., 1925	6,000	\$750,000	\$125	United Oil
Wewoka, Okla.....	Sept., 1923	7,900	3,000,000	370	Dixie Oil
Mid-Continent, Okla., etc....	Jan., 1917	25,000	14,000,000	560	Magnolia
Burbank, etc., Okla.....	Sept., 1923	10,000	7,000,000	700	Mid-Kans. O. & G.
Wilbarger Co., Tex.....	Apr., 1926	4,800	4,000,000	750	Phillips Petrol.
Archer County, Tex.....	Jan., 1926	600	540,000	900	The Texas
Hughes County, Okla.....	Nov., 1925	425	500,000	1,075	Indep. O. & G.
Davenport, Okla.....	Jan., 1926	750	1,000,000	1,333	The Texas
Davenport, Okla.....	Nov., 1924	210	375,000	1,784	Magnolia

‡ Earl Oliver, Tulsa; formerly with Marland, Ponca City. See *Oil & Gas Journal*, February 19, 1925 (C. S. Larkey & R. T. Bright); September 17, 1925 (W. A. W. Krebs). See also page 71 of this book. "Appraisal of Oil and Gas Properties," in 24 chapters, by Johnson & Ruedeman, is for sale by *Nat'l Petroleum News*, 812 Huron Road, Cleveland; price, \$4.

* See papers and discussions, A. I. M. E. meeting, January, 1922; also, the author's forthcoming book on "Oil Finance."

On the *acreage* basis, producing oil land has rarely sold for much less than \$250 an acre. In September, 1925, General Petroleum acquired 40 acres in the Maricopa (Calif.) field at \$15,000 an acre. Proven land at times is worth almost as much as a producing property if the drilling is not expensive. In May, 1926, Amerada Petroleum bought 960 acres in Hutchinson County, Texas Panhandle, for \$580,000 cash. Included were 350 bbls. daily production from 2 wells and 30,000 bbls. stored oil.

Assessed Values of Land, Wells, Interests and Equipment. These vary with the factors already stated. Fairly typical are the following assessed values in Texas. The famous Abrams lease on 1,550 acres in the West



—*Texaco Star.*

PART OF WEST COLUMBIA—WONDER POOL IN WEALTH PRODUCTION

Discovered the same year 1913) as Hull, this Gulf coast pool has produced during the seven years, 1919-1925, almost as much oil as Hull and Humble together, with a value of \$91,000,000. From a financial standpoint, neither Humble nor Spindle Top, each with a higher total output and a higher year's peak, have proven so successful as West Columbia.

The Texas Co.'s No. 1 Abrams has broken all records in yielding revenue. It came in here July 20, 1920, when Gulf crude was quoted at \$3 a barrel. It averaged 26,650 bbls. the first month, making an income of almost \$2,500,000, or at the annual rate of nearly \$30,000,000, which, however, was not kept up. When earlier big wells in the Gulf coast fields came in the price was low, ranging from 3 cents in the early Spindle Top days (at Beaumont) to 45 cents during the flush days of the deep sand in the Humble pool (1915-16). Among the three royalty owners of the 1,550-acre Abrams lease are J. C. McKalip, formerly of Clarion Co., Pa., and Geo. Hamman, a Houston banker.

Columbia field (page 71) cost The Texas Company a small sum a few years ago, but in 1921 it was assessed at \$3,226 an acre. In Navarro County the assessed values per barrel of average daily output during the first quarter of 1926 were as follows for the working interest: \$300 in the Powell pool and \$250 in the Currie and Richland pools. For the royalty interests they were respectively \$500 and \$410. Deep wells were appraised at \$2,000; shallow wells, \$1,000 each; storage oil, \$1 a bbl.; standard rigs, \$1,750 each, and rotary rigs, \$5,000; oil field boilers, \$300 each; oil and gas engines, \$50 a horsepower; pumps, \$25 a horsepower; tanks, from \$100 for 250 bbls. to \$1,250 for 10,000 bbls., with 10 cents a bbl. for those above 10,000 bbls.†

† *The Oil Weekly*, October 7, 1922, and *The Oil & Gas Journal*, April 15, 1926.

DEPLETION AND DEPRECIATION

Value of Assets Vary With Three Factors. A company's resources change in value according to *depletion*, *depreciation* and *fluctuation*. Depletion is the decline due to the removal of oil from a natural deposit. Depreciation is the decline due to the effect of use, exposure, obsolescence, inadequacy and accident upon the physical assets such as tanks, tools and pipe lines. These two factors are more or less under the control of the operator. Fluctuation, on the other hand, arises from causes usually outside of his control, for it is a manifestation of market conditions. Charges consequent upon depletion and depreciation may be considered as supplementary elements of *cost*, although true forms of capital return. Fluctuation relates to the price of the product as sold and as inventoried if kept in stock, but primarily is one of the two factors affecting *gross receipts*.*

Important for Income Tax Purposes. For a long time many operators, notably the large companies which had installed scientific accounting systems, had actually recognized the fact that physical assets are subject to depreciation. But mighty few, if any, of all the oil companies realized the importance of depletion before the war awakened them through the requirements of the income tax laws. Under these laws still in force, both depletion and depreciation are deductible from gross income in order to ascertain the net amount subject to assessment. To many petroleum producers it has proven a blessing in disguise, not the least because it has lightened their tax burden and supplied them with the financial sinews for seeking fresh deposits of mineral oil (under the incentive of the discovery clause).

Depletion Allowance Limited, Acts of 1913 and 1916. Under the Revenue Act of 1913 a reasonable deduction for the depletion of natural deposits was permitted not to exceed 5 percent of the gross mine value of the year's output. This allowance was not commensurate with the value of the oil or other mineral which had been extracted. In the 1916 law the statutory relief to the oil industry was continued, but the restrictive formula was less vigorous. A reasonable allowance for the actual reduction in flow and production, ascertained by regular flow and settled production was permitted. For a long time this deduction was not allowed to lessees but only to the lessors or land owners. Eventually the rule was changed and lessees were given the deduction to which they were entitled.†

* Partly abstracted from "The Business of Oil Production," J. Wiley & Sons, 1922. Investors should beware of flowery statements concerning large profits in which these inevitable cost factors are ignored. An accounting system not allowing for these two can not give a correct profit and loss statement. "In its inflated profits are embodied losses of plant and oil values which have not been deducted as they should have been. The courts uphold the truth of contention that depreciation and depletion are elements of cost." See decision of the Knoxville case, 212 U. S. 1.

† "Dividends from Deficits." According to Barron's *Boston News Bureau*, August 20, 1926, depreciation and depletion charges makes losses apparent where profits are real. "Notwithstanding it is a product of the war-period a corporate accounting practice of mining and oil companies is still confusing. When the Government began to tax American companies on their profits it was found that coal, oil and other mining companies were returning to themselves in the form of dividends what really amounted to a *return of capital*. They were therefore allowed to deduct a certain percentage of their earnings, based on given valuations of their deposits. Such deductions represent depletion of capital assets, and are not taxable as income."

† From "Income Tax Problems in the Oil Industry," by J. J. Cosgrove, formerly with the Bureau of Internal Revenue; now with the Texas Company; paper read before the Fort Worth meeting of the Am. Petroleum Inst., December, 1924.

Discovery Clause Lightened the Tax Burden. In the Revenue Act of 1918 the statutory relief to the oil industry was greatly enlarged. The restrictive formula (of 5 percent gross value) disappeared, and the amount to be recovered through these allowances was broadened to admit new discoveries of oil deposits. Legislative recognition was given to the large sum of money which had been expended in drilling and otherwise developing properties from which no returns were ever received. Under the act of 1921 discovery was limited in its application by the provisions which restricted the deduction based upon such value to the net income from the property upon which the discovery was established.†

Newest Laws Limit Deductions to Fractions of Income. In the law of 1924 deductions for depletion were limited to 50 percent of the net income from the discovery area with the qualification that, where 50 percent of the net income was less than the depletion deduction based upon cost or upon the value of the property as of March 1, 1913, whichever is higher, the larger deduction was allowed. The change was made in a simple but effective manner. The depletion paragraph of the 1926 law, according to final compromise in Congress, provides that only 27.5 percent of the *gross income* from the property may be deducted during the taxable year, and that this sum shall not exceed 50 percent of the net income to the taxpayer (computed without allowance for depletion) from the property, except that in no case shall the depletion allowance be less than if computed without reference to this chapter. (For arguments against abandoning discovery depletion see *The Mining Congress Journal*, December, 1925.)

CURRENT SUPPLY AND DEMAND

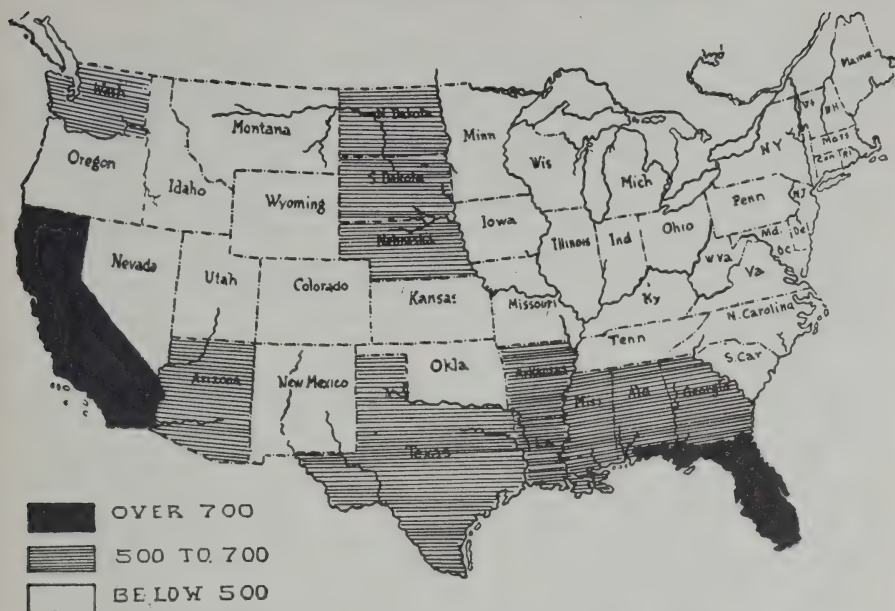
Current Supply Has Three Sources: (1) Production, averaging about 745 million barrels, 1923-1926; (2) stocks of crude and refined, over 538 million barrels on December 31, 1925; and (3) imports, 78.3 million bbls. (79 percent crude) in 1925. Production has several financial-economic problems (chapters V, VI and XIII). While numerically not quite so important in any one year, stocks wield a profound influence on the prosperity of the oil business. The relationship of these three components of supply to each other and to total (current) supply and demand is brought out in the following table (for future supply see Chap. XI).

QUANTITATIVE BALANCE SHEET FOR THE CRUDE OIL BUSINESS, 1925

(Millions of barrels)			
Stocks, crude, Jan. 1.....	409.0	Crude run to stills.....	740.0
Stocks refined, and semi-refined.....	104.0	Crude directly consumed, etc.....	63.5
		Crude exports	13.4
Total stocks, United States.....	513.0	Total crude demand.....	820.9
Production, crude, 1925.....	764.9	Stocks, crude, Dec. 31.....	418.4
Imports, 79 percent crude.....	78.3	Stocks refined, etc.....	120.0
Old and new supply.....	1,355.3	Demand plus stocks.....	1,355.3

At 3.5 bbls. to the ton of coal, the stocks of all mineral oil on December 31, 1925, were equivalent to 2.7 times the stocks of 58 million tons of bituminous coal on hand November 1, 1925. These oil stocks equaled half the world's production in 1925. See art. by Chas. E. Bowles in *The Oil & Gas Journal*, January 1, 1926.

† An amplification of the Law of 1918 and the regulations relating thereto appear as Part 1 of the revised "Manual for the Oil and Gas Industry," Bur. of Internal Rev., 1921. Regulations 65 was modified to give effect to the changes in the Law of 1921.



—Oil Trade.

RECENT DEMAND FOR MOTOR FUEL PER CAR IN THE UNITED STATES

Climatic and economic conditions favor the high rate of consumption in California and Florida (page 111, Part One), which is several times the rate in England, France and Germany where a much greater mileage per gallon is obtained (page 125); Total U. S. domestic demand in 1926 about 256 million barrels of 42 gallons or 500 gallons per motor vehicle exclusive of motorcycles; total exports of gasoline in 1926, about 42 million barrels; total production, 300 million barrels including 12 million barrels of other motor fuel

Of all forms of petroleum the per capita consumption of the United States in 1926 exceeded 6 barrels or 250 gallons, compared with less than 5 barrels in 1921. Refinery consumption of domestic and foreign crude oil was at the yearly rate of over 800 million barrels late in 1926.

Financial Problem of Storage. According to President W. C. Teagle of the N. J. Standard, these are threefold, at least: (1) Finding the capital for increasing storage facilities; (2) an annual budget exceeding \$1,250,000,000 to hold one year's supply of crude alone in storage, and (3) carrying charges of over \$170,000,000 to cover interest, depreciation, evaporation and taxes. Sometimes tankage for flush production is filled but once, and then the unredeemed cost must be written off. Allowances must likewise be made for inventory losses on stored oil incurred through price depressions. During the fall of 1923, more than at any other time in the history of petroleum, operators were obliged either to borrow money or to sell securities for the purpose of carrying crude inventories of their own or of purchasing cheap oil in expectation of price improvements.

Unfavorable Conditions for Storing. As stated on page 81, profits on light oil may be lost through long storage. Gulf crude "A," because of its high percentage of lubricant element, is often improved in storage. For financial as well as economic reasons, open earthen reservoirs are considered very wasteful except for very heavy oils (page 80). Texas authorities have outlawed such storage in the Panhandle field, summer of 1926. Every day a barrel of oil stays in storage adds to its ultimate cost. The annual charge for keeping it in steel tanks varies from 10 cents to 65 cents accord-

ing to the time of storage and the original cost of construction. It is highest in flush fields where tanks may be filled only a few times or used but a year or two. It is the height of financial folly to store oil *above* ground for future sale on a falling market; it had better be left *below*.

Making Money Out of Crude Stocks. In periods of overproduction the renting of storage facilities proves almost as good a source of income as pipe line and tank car transportation. The principal profits, however, arise from the sale of oil bought during periods of oversupply from the many mushroom producers who have no other outlet. Established operators profited in 1925 from disposal of distress petroleum acquired at low cost in 1923. The rising market added considerably to the current assets of those who had carried crude inventories on their books at bottom figures. Prairie Oil and Gas had about 40 million bbls. stored on December 31, 1924, valued at \$66,000,000. Since the rise of 50 cents to \$1 occurred, the appreciated value about the middle of 1925 must have been between \$86,000,000 and \$106,000,000. This was not so bad, remembering that Prairie's capital is only \$60,000,000. Standard of Indiana had upwards of 36 million bbls. crude in storage, January, 1925. An average rise of 70 cents meant a total increment of over \$25,000,000. A gain of 1 cent a gal. on its 200 million gals. of gasoline meant an aggregate advance of \$2,000,000.*

Financial Stabilizing a Function of Storage. While not refusing profits to offset the risk of erecting surplus storage, leading operators really look upon the collective inventories of the industry as a strong stabilizing factor. Such stocks must be drawn upon during periods like the early summer of 1926 when consumption exceeds current production plus imports. Empty storage must be used again whenever flush production, as in the early fall of 1926, may need relief. The natural effect of such practice will be to narrow the swing of the price pendulum between times of oversupply and underproduction to the direct advantage of the public as well as all branches of the petroleum industry.†

FINANCIAL LOSSES AND CONSERVATION

Indirect Financial Losses. F. Julius Fohs recognizes three kinds of natural resource waste which are indirect waste of capital: (1) Failure to recover more of the underground oil, due to natural and economic causes; (2) willful waste; (3) rapid exhaustion of bonanza reserves. Willful waste by legitimate operators is negligible. The advisability of saving bonanza reserves for future generations is debatable. Simultaneously with the exploitation of our bonanza reserves will come increasing importation of foreign oil. The next step will be the mining of oil sands (page 42). Substitutes for crude oil may not be in marked demand for 50 years yet; then the first to be used will be shale oil. Waste in the oil industry is no longer like that of a decade ago.

Purely Financial Wastes. Mr. Fohs has gathered these into 11 groups: (A) Undue money cost, as in paying high commissions for raising capital; (B) unfair promotion practices bordering on fraud (see next chapter); (C) excessive bonuses for leases (already discussed); (D) excess storage, say above 125 days' supply; (E) undersized operating units with heavy

* Wall St. Journal, June 12, 1925, and Boston News Bureau, January 29, 1925.

† See The Lamp, Northrup Cleary, editor, April, 1924.

overhead; (F) oversized units with weakened management; (G) superfluous protective acreage requiring rental outlay; (H) overbuilt condition; (I) graft, pure and simple; (J) undue middlemen's profit; (K) incompetency (Chapter XII); (L) haphazard, sentimental and gambling viewpoint in place of reasoned plan.

Analysis of Five Loss Sources. Regarding *overbuilt condition* this authority gives these causes: (1) Excessive drilling of wells (pages 67, 73, 79 and below); (2) excessive storage and field tanks (pages 74 and 81; (3) a plethora of small refineries (83), and (4) surplus buying of supplies. Graft may relate to (1) promotions, (2) purchase of supplies, (3) letting of contracts and (4) buying of land and leases. Inflated middlemen's profits may arise from (1) sale of crude oil or (2) from sale of products. Incompetency may be traced to (1) lack of good executives, (2) deficient departmental coordination and (3) nepotism. The happy-go-lucky buying and developing of tiny tracts is detrimental in four ways: (1) Attracting to unprofitable affairs capital needed for more legitimate purposes, (2) placing unit values on town lots, etc., disproportionate to possible returns, thereby fixing uneconomic values for larger areas; (3) lacking operative control of production and of water troubles so as to interfere even with legitimate offset drilling; and (4) forcing the drilling of a greater number of wells than is warranted to produce the oil.

Tremendous Losses in Drilling and Producing. Dry holes drilled the past 15 years have cost the industry about \$1,000,000,000. Adding thereto the sum of fully \$600,000,000 for deficits due to operating unprofitable wells brings the total to \$1,600,000,000 or an average of over \$100,000,000 a year lost in the crude oil business alone (economic losses are listed on page 100). In the year 1923 this loss exceeded \$142,000,000 and in 1924, nearly \$115,640,000 (by 2,418 corporation) according to "Statistics of Income" issued by the United States Bureau of Internal Revenue.*

Relation of Losses to Prices and Conservation. Broadly viewed, the losses of an industry must ultimately be paid by the consumer. To perpetuate itself, as stated at the beginning of this chapter, any industry must be profitable in the main and overall profits can not be determined without taking losses into account. Capital losses in the oil producing industry are therefore conducive, in the last analysis, to higher prices. Inefficiency in this respect also results in higher production costs, and these compel a lower recovery of oil. Efficiency in the conduct of oil producing enterprises means lower production costs which permit operating wells for lower daily yields, resulting in greater ultimate recovery of oil from productive sands. From the conservation standpoint, therefore, the efficiency of the oil producer is a matter of much concern.†

Comparative Losses of Mineral Industries. According to the same authority, as revealed in the table below, the aggregate net deficit of the

* Edw. White Statistician, 1925 and 1926. In petroleum refining 213 companies netted about \$146,140,000 and 329 had a deficit of \$33,422,000. Deducting the difference from the \$142,245,000 lost in crude oil production leaves a net deficit of over \$29,000,000 for these two divisions of the petroleum industry.

† Lester G. Uren, of the University of California, before the early 1926 hearing of the Oil Conservation Board, attended by the author.

crude oil business during 1923 was 32 times that of the much more lamented gold mining industry (see footnote on preceding page).

Branches of the mineral industry	Deficits		Net Income		Combined D & NI	
	No.	Millions	No.	Millions	No.	Millions
Crude oil	2,670	\$179.7	1,072	\$37.4	3,742	\$142.3
Coal	2,481	55.9	1,391	133.3	3,872	77.4
Copper	128	11.0	24	22.8	162	11.8
Lead and zinc.....	80	2.7	57	10.7	137	8.0
Iron ore	53	5.7	44	8.2	97	2.5
Gold, etc.....	382	9.9	82	5.5	464	4.4

Corporations only are considered in the above statistics. The deficit of the crude oil business would be even larger if the losses of individual operators were included in the total.

Most Serious Source of Capital Waste is attributed to overdrilling and improper spacing and arrangement of wells. This practice varies widely and in most cases locations are fixed by property lines and competitive conditions rather than by the principles of drainage and economics (page 68). In the Santa Fe Springs field (see index) of 1,400 acres, 45 different companies operate. They have drilled 340 more wells than the field should properly support at an average cost of \$100,000, a total of \$34,000,000.* In their race for early yield they increased the monthly output tenfold to 10,000,000 bbls. in 12 months; result: 96,000,000 bbls. of oil sold at \$1.35 less than the prevailing price before and after the peak of production—an additional loss of \$130,000,000.

Loss of \$218,000,000 in One Field. It is cheaper to produce oil on large tracts under unified control than on small tracts under separate management.* It is estimated that the average cost of oil production by the many companies at Santa Fe Springs has been about 40 cents higher than if the entire field had been worked under single control. This makes a further loss of over \$54,000,000 on the 136,550,000 bbls. produced to the end of 1925. The total of these various losses—from overdrilling, lowered prices and increased costs—amounts to \$218,000,000 or 10 times the original cost of the 220-mile Los Angeles aqueduct.

Enormous Evaporation Losses. Based on Bureau of Mines data, the evaporation bill in 1923 approximated \$200,000,000, assuming that 45,000,000 bbls. of the cream of the gasoline content of the crude escaped into the air. A detailed analysis of the cost of preventing evaporation and the cost of cracking heavy oil into gasoline shows that the net income from a dollar spent on the former is twice the net from a dollar spent on cracking. The estimated loss of about 1,900,000,000 gallons in 1923 was 3 times the output of natural gasoline. This condition, so destructive of natural wealth, is hard to realize.†

* H. L. Doherty, also before the Federal Oil Board, February, 1926, called attention to the fact that "in foreign concessions held in huge blocks, upwards of 100,000,000 bbls. have been produced by a single well" (Mexico, Chapter X); also that "our laws not only produce a shocking waste, but they violate the principles of our form of popular government. If 100 people own property on an oil structure and 99 want to defer production, a single owner can either rob them of their oil or force them to drill at his will. He can carry out his operations so as to sacrifice the greatest part of the value of the deposit." See pages 100-102 and Chap. XI; also *The Oil and Gas Journal*, October 14, 1926, "Unit Operation in New Pools Beneficial," by I. L. Dunn and J. O. Lewis, and November 11, 1926, "Ventura Field Controlled Reservoir," by J. E. Eaton.

† J. H. Wiggins, in *Mining and Metallurgy*, July, 1924, mentions the constant filling and emptying of tanks as the most important cause of evaporation loss since the oil is handled

Financial Losses from Fire and Explosion. Losses from these spectacular causes average likely less than 5 percent of the financial loss from evapora-



—Foamite-Childs Corporation.

A TYPICAL OIL FIELD FIRE DUE TO LIGHTNING

Unlike burning oil wells the supply can not be shut off and dynamiting does no good; but a film of Foamite can extinguish the flames by cutting off the oxygen.



—Foamite-Childs Corporation.

LIGHTNING IS THE LEADING CAUSE OF TANK FARM FIRES

at least 7 times before it gets through the refinery. The loss while in storage is the smallest. See his "Methods of Decreasing Evaporation Losses," Tech. Paper 319, Bureau of Mines, 15 cents from the Supt. of Documents, Washington, D. C. See also *The Oil & Gas Journal*, November 5, 1925.

tion, which is a continuous performance. In oil refining there has been an average of but one fire per plant in 20 years; in pipe line and ocean terminals one in 35 years, and in tank farms one in 81 years before 1926. Crude oil conflagrations are more dangerous than gasoline fires because the former frequently result in boilovers which spread the fire in the absence of proper protection. In volume and value of the liquid burned, lightning seems to lead all causes, but the cigarette and the match are probably to blame for the biggest number of explosions and conflagrations, notably around garages and new oil or gas wells.* Among famous fires



—Rig and Reel Magazine.

WHAT A CIGARETTE DID AS AN AGENT OF DESTRUCTION

Insurance companies complain that one-third of their losses are traceable to the tobacco tyrant. Unquestionably, the meanest menace alike to oil stocks, oil wells, gas wells and gaseous coal mines is the match-lighting cigarette fiend. The spread of the nicotine habit among women and children enhances all the more the hazards to life and limb, health and wealth. In Arkansas two or three years ago, nine innocent lives were snuffed out by a sneaky cigarette carelessly cast away at a gas well.

may be mentioned the Black Tom disaster a few years ago when \$20,000,000 worth of gasoline was lost, and the huge holocaust at Casper, Wyo., where 6 tanks of oil went up in smoke during the summer of 1921. In April, 1926, the Union Oil Co. of Calif. suffered two serious fires from lightning, almost simultaneously, one at San Luis Obispo † and the other at La Brea near Fullerton. The losses aggregated over \$12,000,000, largely covered by insurance. Standard of California suffered about the same time.

* "Smoking, which is always 'strictly prohibited,' has caused many fires. Cases are known of men leaving the rig and going some hundred yards away for a surreptitious smoke. A gentle breeze has carried gas heavier than air in the same direction, and the striking of a match has ignited it, resulting in a flareback to the well which then caught fire."—"The Petroleum Industry," Institute of Petrol. Technologists, 5 John St., Adelphia, London, W. C. 2, Eng.

"Danger in Oil Fires Analyzed," chief engr., by R. G. Hamacker, Humble Oil & Rfg. Co., *Oil and Gas Journal*, October 15, 1925. An excellent article on "Lightning Protection," by Ralph J. Reed, chief engr., Union Oil Co. of Calif., appeared in the *Los Angeles Oil Bulletin*, January, 1925.

† The oil industry's 3-year fire loss, 1918-1920, aggregated only \$14,000,000.—The author, while in the Eng. & Geol. Dept. of the Union Oil Co., 1910, made a map of this 300-acre tank farm situated 8 miles from the sea, at San Luis Obispo.—More than twice as much heavy oil was burned in these two California fires as was consumed at the 4,000,000-bbl. farm of the Texas Co. at Humble in 1905.

CONSERVATION THROUGH COMBINATIONS

Larger Units Favor Welfare of Workers. Conservation of capital, as indicated later, is not the only treasure obtained through proper corporate combinations. The various advantages of mergers have been summarized by a high Government official in the following language: "The Government approves of mergers that promise to cut cost of production, promote exports and benefit consumers. That competition must be met from low European wages during less prosperous times is fully realized. The object of the Government is to help maintain a more than living wage. The thrifty wage earner is entitled to a surplus the same as the corporation, the banker and the broker. This means continued prosperity, for without reasonable wages to consume the country's products, the result would be idleness. Little units have a hard time making money, and this means that they have trouble paying good wages. The Nation's growth is so rapid that larger units are essential to the welfare of the people." *

Memorable Period of Mergers. During the period 1917-1923 were born numerous would-be oil companies. Some survived and prospered so long as their undrilled acreage lasted. Few of the concerns confined to the production of crude did so well as those which also refined and marketed their products (page 103, "vertical monopoly"). Recognizing the benefits of a balanced organization, a number of the new companies combined in groups of two or three. The greatest era of corporate merging came in 1925 and continued into 1926. There were oil deals galore back in 1900-1902, but together they did not compare in volume or value with the seven most significant acquisitions and groupings of 1925-1926.

Seven Groupings Aggregate \$600,000,000. By September, 1926, seven recent transactions involved the transfer of about 325,000 barrels daily yield of oil and of some \$600,000,000 in cash and securities, as shown in the table herewith.

DATA ON SEVEN ABSORPTIONS AND MERGERS COMPLETED,
MARCH, 1925-SEPTEMBER, 1926

Companies	Where operating	Daily crude	Millions	New owners
Pan American	Mexico, U. S. and			Standard, Ind.; Chase Nat'l
P. & T. Co.	Venezuela	145,000	\$35.	Bank, Blair & Co., etc.
Magnolia Pet.	Okla., Tex., Ark.	35,000	98	Stand., N. Y., incr. to 100%
Ventura Consol. and				California Petroleum Corp.
Mohawk	California	10,000	18.7	
Waite Phillips	Kans., Okla.	11,500	25	Barnsdall Corp. (Blair)
Pacific Oil	California	55,000	200	Standard Oil of Calif.
Associated Oil	Calif., Mex., Tex.	50,000	150	Tide Water Associated
General Petrol.	Pacific Coast	30,000	70	Standard Oil of N. Y.

Few Motives for Mergers. An analysis shows three causes for the recent epidemic of combinations: (1) The desire for greater reserves of unmined oil to insure non-interruption of operations (Pacific Oil increased Standard of California's potential to 180,000 bbls. daily, and Associated boosted Tide

* *Wall St. Journal*, March 23, 1926. An editorial in *The Mining Congress Journal*, July 1926, read in part: "We have found no evidence of public resentment against consolidations in industry necessary to insure continued prosperity and growth. * * * People begin to realize that the greatest relief that may be expected from present high prices for necessities will come through business combinations needed for reducing overhead costs and costs of marketing, and to eliminate waste of economic effort through better coordination of agencies of production and distribution."

Water's current yield from 16,000 to 66,000 daily); (2) the need of better balanced operations geographically considered; (3) the necessity of rounding out activities "vertically" so as to have complete control from the oil field to the filling station (Waite Phillips with its Mid-Continental production of crude and natural gasoline as well as marketing facilities supplemented Barnsdall's bold wildcat operations extended to California and even Russia).*

East Weds West. An even more harmonious union than the California combination of Pacific and Standard † was made when Tide Water took unto



KENNETH R. KINGSBURY

President, Standard Oil Company of California

A "Buckeye" by birth in the Centennial year, he began his petroleum career in Pennsylvania with the Standard Oil Co. in 1897 after graduating from Princeton and specializing in mining engineering at Columbia.

When the dissolution decree went into effect in 1911, he was made vice president of the Standard Oil Co. of Calif. He became its president in 1919, and under his able administration the company has earned fully \$260,000,000 net for dividends and surplus in eight years. His company ranks third among Standards in dividends paid since 1911. His latest "coups d'état" was the absorption of Pacific Oil with its huge reserves, making the new Standard of California by far the strongest operator on the Coast, with assets valued at over \$600,000,000.

—*Oil Bulletin.*

itself Associated in March, 1926. Although having but two-thirds the refining capacity of the other, Tide Water turns out a greater variety of products from its big Bayonne (N. J.) plant and is much better known

* See "Huge Mid-Cont. Mergers Strengthen Industry," D. W. Moore in *Oil Trade*, February, 1926: "Since 1919 the oil business has been carrying much deadlocked material—inflated capital, overstocks of equipment, idle refineries and pipe lines, etc.—largely accumulated as a result of bad judgment and the idea "every man to himself." See also *Oil and Gas Journal*, January 12, 1926, p. 88, and *Wall St. Journal*, June 28, under "Oil Mergers Based on Need For Crude."

† The greatest grouping was that of Pacific Oil and Standard of Calif., which made the new Standard second only to Standard of N. J. in the market value of securities and also in surplus as of December 31, 1925. The merger was announced December 24, 1925, by President Kingsbury of the Standard. Paul Shoup, formerly president of the Associated and now vice president of the Tide Water Associated, was quoted in the *Phila. Public Ledger*: "All who have studied this important consolidation must be convinced that it will serve the public beneficially. It promotes economies in operation, helps place oil and its products in markets most needed with the least cost in money and time, reduces the amount of oil unavailable through transit and storage status, gives increased facilities for resolving crude petroleum into products according to the Nation's needs; in short *provides conservation in the best possible way.*"

Axtell J. Byles, pres. of the Tide Water Associated, in the *N. Y. Times*, April 18, 1926: "The consolidated company will be in a more favorable to expand the huge export trade in Europe and the Orient. Through acquisition of the California properties products heretofore shipped from the Atlantic coast to the Orient will in the future be sent from the Pacific, thereby shortening the distance by some 3,000 miles and thus releasing tankers for other markets."

abroad. The bulk of Associated oil comes from comparatively few wells in California, while Tide Water obtains its 16,000 bbls. from 5,000 wells scattered over the Appalachian field, Illinois and the Mid-Continent. The combined fleet of 17 tankers has a carrying capacity of almost 1,000,000 bbls. In 1925 the two produced and purchased 7 percent of the United States output of crude. Their products sold for \$150,000,000. The sum of their net profits available for dividend and surplus approximated \$17,700,000, or 11.8 percent of gross sales. On December 31, 1925, the ratio of current assets to current liabilities was 4.8 to 1, reflecting a sound financial condition for the combination.

General Petroleum to Standard of N. Y. Having previously (in 1925), taken entire control of Magnolia Petroleum * with its 30,000 or more daily



THREE DISTINGUISHED CALIFORNIA OIL MEN

At the left is E. J. Miley, president of the Miley Oil Co. and the State Consolidated Oil Co.; in the center, L. P. St. Clair, vice-president, Union Oil Co. of California, and at the right, Mark L. Requa, ex-director, Oil Division, U. S. Fuel Administration, 1918-19, and one time chairman, valuation committee, Independent Oil Producers Agency of California. A fourth Californian, E. W. Clark, is now (1927) president of the American Petroleum Institute.

—Oil Bulletin.

yield in the Gulf Coast and Mid-Continent (at a cost of \$98,000,000 for the remaining 30 percent minority interest), Standard of New York proceeded in the spring of 1926 to absorb the 10-year old General Petroleum, a complete California unit with a like amount of crude production (at a cost estimated at \$70,000,000). These additions increased the assets of the Standard of N. Y. to a total of about \$600,000,000, and in this respect made it second only to the Standard of N. J. Magnolia assets had been rated at \$225,000,000 and those of General Petroleum at \$115,000,000,† thus leaving

* Magnolia was formed April 24, 1911, by the late John Sealy who owned refineries at Beaumont and Corsicana. Capital stock of \$2,450,000 was increased to \$188,000,000 by March 11, 1924. Greatest impetus came with the purchase of the McMan Oil Co., January, 1917, with 25,000 bbls. daily yield and 2,000,000 bbls. in tanks for \$16,200,000. See *Wall Street Journal*, March 3, 1926.

† General Petroleum was built up by Capt. John Barneson and Sons, L. T. and J. L. It reached a peak of 56,000 bbls. daily in June, 1923. It developed wholesale distribution from San Francisco to Seattle. (See footnote on next page.)

President Herbert L. Pratt issued this statement about the middle of April, 1926:

other assets of the N. Y. Standard at about \$260,000,000, mainly in the form of refining and marketing facilities with numerous foreign stations.

EARNINGS OF THE ENTIRE INDUSTRY

Various Sources of Income. Income from oil may be derived by individuals or corporations considered either as operators or as outsiders. A farmer may receive bonuses, rentals and royalties without incurring risk or expense. A lot owner in a city may do the same and a realtor may sell land at a profit due to the nearby discovery of petroleum. A broker may deal in leases, royalties and oil shares. These outsiders take few, if any, chances and invest little or no capital in oil ventures. Their income may rightly be regarded as outgo from the regular oil business and as an element of cost not to be overlooked. Operators within the oil world receive income from various sources or activities: (1) Sale of leases or subleases; (2) over-riding royalties; (3) oil production; (4) casing head gasoline; (5) sale or rent of used equipment; (6) pipe line transportation; (7) tank farm storage; (8) rent of tank cars; (9) marketing purchased crude; (10) refinery operation; (11) domestic retailing of products; (12) export trade; (13) jobbing. Nearly 90 percent of the operators produce and sell crude only.

Comparative Income. Corporation business of all kinds in the United States aggregates annually 100 to 120 billion dollars—hardly one-third of our national wealth but 10 times the yearly value of our agricultural products. According to Richard F. Grant,* the 100 billion is made up as follows: Manufacturing, 60 billion; trade, 31 billion; mining, 6 billion; construction, 3 billion (8 billion in 1926). Crude oil, a product of mining, brings 1.2 billion; manufactured forms of petroleum hardly 3 billion at the refineries, but after delivery here and abroad must sell for a sum between 4 and 5 billion dollars (pages 82-86). The ultimate gross income of the oil industry is not excessive considering the expenditures involved for its maintenance—from the finding of new deposits to the modernizing of its manufacturing plants and the construction of new filling stations for the public.

Net Income from Producing and Refining. While the relatively hazardless refining branch of the oil business has been paying profits, largely because of its greater efficiency, the crude oil branch has again been doing otherwise, beginning with a price slump in 1921. Balancing the total of

"Standard Oil Co. of N. Y. and its subsidiary have created intensive distributing facilities in (certain parts of) the United States. * * * It has also developed widespread facilities in China, Japan, India, Philippines, Java, Straits Settlements and the Near East which represent a large investment. While it has created this extensive marketing organization, * * * it has neither enough crude production nor adequate refining capacity to furnish all the petroleum products which it markets. * * * General Petroleum, on the other hand, has extensive producing properties in the California field which in 1925 produced about 10,000,000 bbls. of crude besides buying 15,000,000 bbls. * * * It has refineries at Los Angeles which in 1925 handled 18,000,000 bbls. of crude oil. It has marketing facilities * * * on the Pacific Coast. The business of the two companies is therefore complementary."

* President of the Chamber of Commerce of the U. S. See "The Case for the Investor," *Nation's Business*, February, 1925. Income at the refineries totals about the same as the annual Federal taxes while the retail market value of the many petroleum products (page 58) approximates the amount of money in circulation (about \$4,800,000,000) or the combined value of the corn and cotton crops.

corporation deficits against the total net income of the successful corporations gave a net income of 153 million dollars in 1919, disregarding the income and deficits of the many individual producers of crude oil; in 1921, a net loss of almost 82 million dollars; in 1923, a net loss of 142 millions, and in 1924, a net loss of 24 millions. Combining the balances of the crude oil branch with that of refining, gave a total income of 318 million dollars in 1919 in contrast with a net deficit of 29.5 millions in 1923 and a net income of 166 millions in 1924, based upon "Statistics of Income," by the Bureau of Internal Revenue. In 1925 the aggregate net income of the 65 leading operators approximated \$650,000,000—probably between 14 and 16 percent of their gross revenue. This included income of transportation and marketing subsidiaries and was much greater than in 1924. The 1919 Federal figure for the profit was 13.2 percent of the combined gross of almost \$2,400,000,000, and the 1923 loss amounted to 1.06 percent of the \$2,772,000,000 gross income.

Refining More Stabilized Than Producing. The foregoing emphasizes the facts well known within oildom circles: (1) That oil production is the precarious division of the industry having lately proved profitless during a period of three consecutive years although at times yielding good returns (20 percent in 1919) commensurate with the admittedly high hazards, and (2) that the refining division is the more stabilized, rarely (if ever) revealing an absolute loss as a whole, but generally returning good profits to the various operators, particularly those of the vertical monopoly type who possess their own marketing facilities.



—Standard Oil Bulletin.

SALES FORCE OF THE CALIFORNIA STANDARD

These are the men behind the marketing guns, who, under the generalship of the late J. C. Fitzsimmons, made their concern the leading distributor of petroleum products on the Pacific Coast.

How to Increase Gross Income. The ultimate income to the oil industry may be magnified in various manners: (1) By increasing crude production and refinery runs consistent with demand; (2) by procuring better prices; (3) by multiplying the recovery of the more valuable products at the expense of the others; (4) by controlling utilization so that no petroleum product may compete with cheaper or more abundant commodities such as

coal. The procural of good prices has already been considered under "Margin Between Cost and Market Value." Points (3) and (4) have been very nicely treated by Roland B. Day, who advocates more universal cracking of heavy oil into gasoline and the removal of 230 million bbls. of fuel oil from competition with coal, thereby enhancing the gross income above cost of crude by \$193,000,000 per annum.*

INCOME AND PROFITS OF LEADING OPERATORS

How Profits are Determined. "Gross income" is the most comprehensive term since it takes in "gross earnings" from all regular operations as well as incidental and occasional revenue from various sources, such as interest, rent and sale of property (see "Earnings of the Entire Industry"). Not all oil companies publish the amount of their gross earnings or sales without deducting "cost of materials." Operating, general and administrative expenses are deducted from gross to get "net earnings." Then come "adjustments," plus or minus, of crude and refined inventories according to the market (on December 31 of each year), if these are not carried on a cost basis. The next step is to set aside additions to reserves for "depletion and depreciation" before taking out the amount for Federal taxes. The result represents "net income" as recognized by the Treasury Department. After reserving the Government's share the remainder is designated as "net earnings after depletion, depreciation and Federal taxes" or simply "net (available) for dividends and surplus" equivalent to "net profit."



—The Oil & Gas Journal.

"DESERT SHIPS" DRAW "CARGOES" OF AMERICAN PETROLEUM PRODUCTS ACROSS DRY STRETCHES IN AFRICA AND AUSTRALIA

Camels do not always carry loads on their backs. In this view is seen a large wagon load of case oil hitched to a string of these hardy quadrupeds. As here implied, the Standard as well as other American companies doing business abroad, incorporate their foreign subsidiaries in the lands where they operate.

Earnings Cover Operations Abroad. The financial statements of only a few operators reveal the rate of gross earnings. The following figures, in millions, for 1925 largely represent gross sales, include indirect income

* "Economic Aspects of Cracked Gasoline," *Oil and Gas Journal*, November 26, 1925; reprinted with other related papers in book form by Universal Oil Products Co. (owners of the Dubbs cracking process), 310 So. Mich. Ave., Chicago.

Read "A Producing Program for Profits," address of George Otis Smith before the International Petroleum Congress, printed in *The Oil Trade*, November, 1924.

from pipe line transportation and in the case of the first named consists in a great measure of subsidiaries' earnings, notably from natural gas operations.

Standard of New Jersey.....	1,222.7	Atlantic Refining	138.0
Standard of Indiana.....	286.0	Union Oil of Calif.....	74.0
Gulf Oil Corporation.....	215.6	Marland Oil	65.0
The Texas Company.....	208.0	Shell Union	50.0
Sinclair Consol.	160.0	Sun Oil	49.0
Tide Water Associated.....	150.0	Phillips Petroleum	36.0



—Texaco Star.

AN EFFICIENT SALES FORCE OF AN AMERICAN COMPANY IN CHINA

Practically all of these as well as the Standards of Calif. and N. Y., Pan American, Shell Union and Vacuum, participate heavily in the export trade so that an appreciable percentage of their income must be credited to foreign sales.

Comparison of Net Profits. One of the best bases for ranking the operators is their total net profits as shown below in *millions of dollars*.

Standard Oils			Independents		
	1923	1924	1925		
Standard, N. J.....	56.3	81.0	111.2	The Texas Company.....	8.2 26.5 39.6
Standard, Ind.	41.5	40.8	52.9	Gulf Oil Corporation.....	14.3 19.2 35.0
Standard, Calif.	31.3	35.6	43.6	Shell Union Oil Corp.....	16.9 18.6 20.4
Standard, N. Y.	15.0	22.0	41.6	Tide Water Associated....	8.9 10.3 17.7
Pan American P. & T....	20.4	15.2	27.3	Marland Oil Co.....	1.7 0.35 14.8
Vacuum Oil Co.....	13.3	17.2	24.2	Pure Oil Co.....	11.7 10.6 12.9
Humble Oil & Refining...	5.1	9.8	22.6	Phillips Petroleum	4.6 7.2 12.3
Prairie Oil & Gas.....	8.8	10.3	15.8	Union Oil Co. of Calif....	8.0 10.7 10.5
Magnolia Petrol Co.....	8.1	8.5	...	Mid-Continent Petroleum...	3.8 1.4 7.0
Ohio Oil Co.....	6.1	4.5	9.4	General Petroleum	6.0 8.3 6.4
Standard, Ky.	5.5	5.4	7.5	California Petroleum	6.7 3.5 6.3
Atlantic Refining	0.8	4.7	7.2	Sinclair Consol. Oil.....	def. def. 6.0
Standard, Nebr.....	5.5	5.4	7.2	Mtn. Producers Corp.....	6.9 6.4 ...

In the above table the net earnings of the Pacific Oil Co. have been included for the 3 years with those of the Standard Oil Co. of Calif. although the merger was not announced before December 24, 1925. Profits of Magnolia Petroleum Co. in 1925 have been combined with those of the Standard of N. Y., which in that year increased its control from 70 to 100 percent; but those of General Petroleum have been excluded since this California operator was not absorbed before May 17, 1926.

With only one exception all of the 26 companies listed above did incom-

parably better in 1925 than in 1923, the year of most phenomenal over-production. Marland Oil showed 770 percent improvement, and Atlantic Refining, 800 percent. Very few failed to better their 1924 earnings. Among minor companies the 1925 net profits were as follows, in millions of dollars: Tide Water alone 6.0, Salt Creek Producers Association 4.6, Continental Oil Co. 4.3, Pan American Western Petroleum 4.2, Skelly Oil 3.8, Sun Oil 3.6, Barnsdall Corp. 3, Standard of Ohio 2.97, American Republics 2.86, Simms Petroleum 2.64, Independent Oil & Gas 2.56, Amerada Corp. 2.50, General Asphalt 1.52, White Eagle Oil & Refining 1.47, Houston Oil 1.25, Louisiana Oil Refining 0.87, Transcontinental Oil 0.79, Galena Signal Oil 0.59, Standard of Kans. 0.49. For net in 1926 see page 367.

Net Profits per Share of Common. For investment purposes this means more than the total profits if income available for dividends and surplus is the main desideratum. Designated as "Per Share Earnings" in the leading financial newspapers, *Barron's* and *The Wall Street Journal*, these have been combined in the table below: *

Companies	1923	1924	1925	Companies	1923	1924	1925
Amerada Corp.....	\$3.11	\$2.85	\$4.24	Pure Oil.....	\$3.57	\$3.10	\$3.70
Associated Oil	3.39	2.85	4.67	Salt Creek Prod.....	4.60	4.18	3.09
Atlantic Refining	nil	6.59	11.53	Shell Union Oil.....	1.84	1.74	1.86
Barnsdall Corp.....	0.14	1.52	3.29	Simms Petroleum.....	.51	2.81	3.85
Calif. Petroleum.....	5.65	2.96	3.26	Sinclair Consol.....	nil	nil	0.95
General Asphalt.....	3.56	6.04	5.78	Skelly Oil.....	1.36	0.95	4.43
General Petroleum.....	5.56	7.17	5.49	South Penn Oil.....	nil	7.63	11.87
Gulf Oil Corp.....	3.29	4.40	7.99	Standard, Calif.....	2.48	2.84	3.46
Houston Oil.....	3.97	3.93	2.87	Standard, Ind.....	4.68	4.55	5.84
Humble Oil & Rfg.....	2.89	5.62	12.95	Standard, Ky.....	8.22	7.98	10.62
Indep. Oil & Gas.....	1.62	1.42	5.12	Standard, N. J.....	2.10	3.30	4.72
Marland Oil.....	1.52	0.23	7.80	Standard, N. Y.....	1.66	2.42	3.62
Mid-Continent Pet.....	nil	0.70	4.68	Sun Oil.....	1.38	1.90	3.40
Ohio Oil.....	2.54	1.90	3.90	Tex. Pac. C. & O.....	nil	.04	.86
Pacific Oil.....	2.55	3.40	4.70	The Texas Co.....	1.24	4.02	6.02
Pan Am. P. & T.....	7.96	5.67	9.95	Tide Water Oil.....	†1.45	†1.95	2.81
Pan Am. Western.....	....	4.34	8.47	Union Oil, Calif.....	2.23	2.83	2.78
Phillips Petroleum.....	3.92	3.82	5.12	Vacuum Oil.....	5.42	7.02	9.73
Prairie Oil & Gas.....	3.68	4.30	6.58	White Eagle O. & R....	2.93	2.24	3.04

A par value of \$25 a share appears to be popular with oil companies, and in line with the extension of stock ownership among employes there has been noted a recent trend to reduce the original par of \$100 to the smaller unit. Among those who retain the \$100 par value are Atlantic Refining, Houston Oil and South Penn. A limited number have not assigned any par value to their common stock. Otherwise comparisons may be made in the above table both vertically and horizontally. In the latter way it will be seen that the figures reflect a remarkable recovery of practically all these companies from the depressed condition prevailing in 1923. Only three of the 38 were guilty of backsliding.

Ratio of Profit to Par a Superior Criterion. Of greater significance to the investor who may not be satisfied with the combination of greater safety with smaller rate of return (offered by older operators), is the percentage which the net for dividend and surplus makes of the par value of the common. From the foregoing table, with the knowledge of the par value, the *rate of return* may be calculated quickly (see end of chapter). However, if the market price is below or above par, as it usually is, the new buyer of stock must calculate rate of yield on other than par value. Among the

* See chart of 50 oil companies published by Ward, Gruver & Co., 20 Broad St., N. Y.

† On basis of the new \$25 par value instead of the old \$100 par, for the sake of uniform comparison. South Penn changed to \$25 par early in 1927.

higher rates for 1925 may be mentioned 52 percent on par for Humble, 39 for Vacuum, 38.5 for Simms, 31.8 for Gulf, 31.3 for Pacific, 30 for Phillips, 24 for Texas, 23.4 for Standard of Indiana, 22.3 for Marland, about 20 for Pan American Petroleum & Transport, and nearly 19 for Standard of N. J. Rates not quite so good include those of Pure Oil, 14.8 percent; Standard of N. Y., 14.5; California Petroleum, 14; Barnsdall, 13.2; Standard of Calif., 13; South Penn, 11.9; Atlantic Refining, 11.5; Tide Water, 11.2, and Union Oil of Calif., 11.

Dividend Rates More Regular. While the earning rates on par in 1925 ranged from 52 percent for Humble down to 1 percent for Sinclair, the dividend rates did not depart so very much from the average, disregarding the companies that pass dividends for an entire year. In 1925 Standard of Nebraska and Vacuum paid at the rate of 20 percent on common, Standard of Kentucky at 16, Shell Union at 14, The Texas Company at 12, and the following at 10 percent: Continental, Ohio Oil, Standard of Indiana and Standard of Ohio. California Petroleum, Pure Oil, Prairie Pipe Line and Standard of California paid 8 percent. Union Oil of Calif. distributed at the rate of 7.2 percent on its issued common stock, Atlantic Refining at 7 percent on its preferred and none on common. Gulf Oil and Marland each at 6 percent, and Standard of N. J. at only 4 percent (see end of chapter).

1925 Swelled Total Treasures in Dividends. Dividend payments during 1925 probably totaled a little more than those of the preeminently prosperous year 1920, and have never been equaled in any other year. Improvements over 1924 were not restricted to any one area nor to operators in any particular branch of the industry. At least 10 companies paid extra dividends in cash or stock. Three other sources of larger payments were increased dividend rates by 9 or more companies, resumption of dividends by a few, and the making of initial payments by others. The only important omission was the passing of two quarterly payments by Prairie Oil & Gas. Like a few others, its best years were 1919 and 1920 in each of which it paid \$5,040,000 or 28 percent on its capital stock.* The five foremost dividend-payers in 1925 were: Standard of N. J., 14 million on preferred and 20.4 million on common, making total of 34.4 million dollars; Standard of Ind., 22.5 million; The Texas Co., 19.7 million; Standard of Calif., 18.9 million, and Pan American P. & T., 16.5 million. Other important payers (on common) included: Standard of N. Y., 14.3 million; Shell Union, 14 million; Vacuum, 12.4 million; Pacific Oil, 7 million; Gulf Oil, 6.6 million; Ohio Oil, 6 million; Marland, 6 million; Pure Oil, 4.9 million (plus 1.7 million on preferred, making total 6.6 million); Associated, 4.2 million. The Texas Co. leads all independents with a total of \$210,000,000 paid to the end of the third quarter of 1926. Since the dissolution of 1911 the leading Standards had disbursed the following totals (in millions) to the middle of 1926:

* Reduced to 8 percent in 1923 and 1924 following a 200 percent stock dividend in 1922. On cash dividends are considered here: the subject of stock dividends will be taken up in the next edition of this book and possibly in a separate volume devoted exclusively to petroleum finance and commerce.

Standard of Ind. promises to distribute \$33,000,000 in 1926 to its numerous stockholders. This should be within \$2,000,000 of both preferred and common dividends that will have been declared by Standard of N. J. in 1926. See *Wall Street Journal*, November 17, 1925, May 24, 1926, August 16, 1926; also "Dividends from deficits," *Barron's*, August 30, 1926.

Standard, N. J., pfd.....	88.2	Prairie Pipe.....	63.5
Standard, N. J., com.....	31.1	Prairie O. & G.....	51.8
Standard, Ind., com.....	174.8	Magnolia.....	43.8
Standard, Calif.....	158.8	Vacuum Oil.....	36.6
Standard, N. Y.....	136.8	Standard, Ky.....	18.0
Ohio Oil.....	122.3	Humble.....	15.8



A TYPE STUDY IN OIL—THE TEXAS COMPANY

Reasons for Selection. This concern was chosen for the type study in this edition because (1) it has a splendid reputation, (2) represents the independents, (3) operates in all but three states, (4) is best known abroad next to the New Jersey and New York Standards, (5) has enjoyed a healthy, steady, harmonious growth for over 25 years, (6) is unusually well balanced, (7) has officials of high character, broad minds and friendly feelings toward the helpful activities of the Government,* (8) is physically and

* In 1922 the general counsel of The Texas Co. was selected by Uncle Sam to serve on a high commission requiring courage, tact and dispatch. The *N. Y. Tribune* contained one of many complimentary editorials: "President Harding's nomination of an able Democrat, Attorney Edwin B. Parker, to the General German Claims Commission, shows a spirit of generous non-partisanship. The appointment is wholly admirable * * *."

"All for Each—Each for All" is the motto of this great corporate family. "Its affairs cover the entire range of the petroleum industry and extend over the face of the earth."—Editor Lefevre in *The Texaco Star*, October, 1922. "Around the World with Texaco," is the title of a book by the globetrotter, C. S. Dennison. It is popular with pupils and teachers who like real and recent geographic facts liberally illustrated.

financially strong enough to withstand the worst winds, (9) is famous for its efficiency and (10) pays annual dividends of almost 20 million dollars or little less than either one of the two leading Standards, considering common stock.

Born at Beaumont in 1901. Its predecessor, The Texas Fuel Co., was "spudded in" near Spindle Top (pages 40-41 and Chap. VIII) but 77 days after the great Lucas well began to belch forth. The Texas Co. was incorporated April 7, 1902, with a capital of only \$3,000,000 and only 119 stockholders. Natural growth caused successive increases in capital which has been \$164,450,000 par since 1921.* The stockholders numbered 32,826 in September, 1926. The original roll of 12 employes grew to 27,000 by 1920. In 1917 the company was authorized directly to produce oil, so the Producers' Oil Co. was dissolved. About the same time the Texas Pipe Co. and the Texas Pipe Line Co. of Okla. were formed, also The Texas Co. of Mexico. The big event of early years was the 1903 purchase of Sour Lake, the pool which to 1926 produced more oil than any other in the Gulf Coast field except Humble. The company's development of its 800 acres brought Sour Lake up from 45,000 bbls. in 1902 to 8,848,000 in 1903 (then half the output of all Texas).‡ Operations were extended into Oklahoma with the opening of the Glenn pool (1906) and intensified with the deeper (Bartlesville sand) development in the Cushing district (1914). The pipe line from West Tulsa to Port Arthur was built in less than 5 months (by June, 1907), but the most sensational scene was laid in July, 1920, at West Columbia, 50 miles west of Galveston. Here the company during one week produced from a single well oil worth \$80,000 daily and reaching a maximum rate of 33,000 bbls. daily, probably the most profitable producer for any six-month period in history. (See view of Abrams No. 1, page 320.)

A Few Physical Facts. Usually but 10 percent of controlled acreage is owned by an oil company in fee. The Texas Co., however, in 1925 thus held almost 30 percent of its 1,690,000 acres. Its 3,114 domestic wells averaged 18.7 bbls. per well per day; its 23 Mexican wells 88.2 bbls., making a combined average of 19.2 bbls., nearly thrice the average for all the 306,100 wells in the United States, December 31, 1925. Of 453 domestic wells completed that year 27 percent proved dry; of 7 Mexican, 57 percent. In 1925 about 21.2 million bbls. of crude oil were produced and 21 million were bought in the United States; respectively $\frac{3}{4}$ million and $2\frac{1}{2}$ million in Mexico. Of the total, 45.4 million bbls. 34.4 million were run through the company's refineries in Illinois, Louisiana, Oklahoma, Pennsylvania, Texas and Wyoming. Gasoline recovery increased from 40 percent of 35.9 million bbls. in 1924, to 44 percent from 34.4 million in 1925. Pipe lines now measure almost 5,000 miles and the tankage, 40,000,000 bbls. The company owns or leases 5,400 tank cars which each averaged 11,400 miles of travel in 1925. Its 19 steam tankers and 4 motor vessels carry yearly about 3.5 million tons or 20,000,000 bbls. of oil.†

* In the fall of 1926 was created the new corporation, The Texas Co. of Del., with \$250,000,000 authorized capital. This harmonizes better with its huge assets.

† Further details in *Texaco Star*, April, 1926; *Barron's*, March 8 and May 10; *Wall Street Journal*, April 25, 1924, under "Texas Company Tells Operating Story: First of Large Oil Companies to Outline in Detail Operations in Its Departments." H. G. Lapham, a director, stated in *Barron's*, December 20, that late in 1926 refinery runs and reruns totaled 140,000 bbls. daily, six-sevenths at the Port Arthur plant.

Financial Information. Only one other independent had a gross income in 1925 greater than the \$208,000,000 of The Texas Co. Deducting \$48,600,000 for cost of materials left a little less than \$160,000,000 as the earnings. Operating expenses approached \$90,000,000, and after allowing for depletion and other deductions, including dividends of \$19,700,000 there remained a surplus which added to that of 1924 (\$95,200,000, less adjustments) brought the surplus up to \$113,500,000 on January 1, 1926. Following is the *consolidated income statement* for 5 years, values expressed in millions as of December 31 of each year:

	1921	1922	1923	1924	1925
Gross earnings during year.....	\$102.6	\$131.0	\$118.4	\$139.6	\$159.4
Operating expenses, etc.....	73.0	80.6	87.5	89.1	89.4
Net earnings	\$29.6	\$50.4	\$30.9	\$50.5	\$70.0
Changes in crude inventories, etc.....	10.6	7.4	6.5	4.8	8.3
Depletion, depr., Federal taxes.....	9.7	16.4	16.2	19.2	22.1
Net income for dividends and surplus.....	\$9.3	\$26.6	\$8.2	\$26.5	\$39.6
Previous surplus with adjustments.....	92.3	88.0	99.9	88.4	93.6
Balance before dividends.....	\$101.6	\$114.2	\$108.1	\$114.9	\$133.2
Dividends paid during year.....	18.1	19.7	19.7	19.7	19.7
New surplus at end of year.....	\$83.5	\$94.5	\$88.4	\$95.2	\$113.5



—Texaco Star.

MOFFAT DOME, COLO., WHICH THE TEXAS CO. (JOINTLY WITH THE TRANS-CONTINENTAL) FIRST DEVELOPED

All assets of The Texas Co. must approach \$500,000,000 in value at the close of 1926 considering its *rich reserves* in 8 states and in Latin America, its *growing production* of over 65,000 bbls. daily (3 percent of the United States total, mostly settled and worth more than the \$500 a bbl. carried on the books), its *refining capacity* of about 160,000 bbls. daily (especially the huge capacity for cracking by the Holmes-Manley process, and last but not least, its world wide good will which has not been capitalized in the records. Oil lands and stocks of merchandise are largely undervalued by this modest

company according to the balance sheet which shows total assets a little below \$400,000,000. The strongest proof of success is found in the fact that net profit for dividends and surplus exceed \$300,000,000 to the end of 1926.

BALANCE SHEET OF THE TEXAS COMPANY AS OF DECEMBER 31, 1925 (in millions)

Fixed Assets:		Basic Liabilities:	
Refineries and terminals.....	\$70.25	Capital stock (common).....	\$164.45
Lands, leases, wells, equipment...	55.55	Surplus	113.47
Pipe lines and tank farms.....	52.06	Capital and surplus.....	\$277.92
Sales stations, facilities, etc.....	41.33	Reserves for depletion and depreciation	\$96.58
Ships and marine equipment.....	29.10	for amortization.....	2.43
Tank cars, other ry. equip.....	5.82		99.01
Total fixed assets.....	\$254.11		
Current Assets:		Major liabilities.....	
Merchandise, crude and refined...	94.42		\$376.93
Accounts receivable.....	19.15	Current Liabilities:	
Cash on hand and in banks.....	18.81	Accounts payable.....	14.03
Storehouse supplies.....	5.66	Federal taxes (estimated).....	4.50
Notes receivable.....	2.82	Notes payable.....	1.23
Miscellaneous Assets: (a).....	2.67	Miscellaneous Liabilities:	
Total assets.....	\$397.64	Deferred purchase obligations....	.95
(a) Securities \$1.14 mil. and deferred charges.		Total liabilities.....	\$397.64



—Texaco Star.

PART OF THE TEXAS CO.'S TERMINAL AND REFINERY AT PORT ARTHUR

Review and Recent Events. This company is firmly entrenched financially as shown by its modestly appraised assets and its enviable earning record of a quarter-century. It has never failed to pay dividends although, like other oil operators, its earning in 1921 and 1923 did not cover these requirements. In 1925 its earning rate on par was 24 percent, or far better than the average. Its dividend rate was 12 percent. Current events have foreshadowed additional benefits to stockholders. One has been the boost in its gasoline business by the introduction of Texaco high-test motor fuel (see *Philadelphia Ledger*, August 13, 1926). Another has been the purchase



—Courtesy of Editor Lefevre of the *Texaco Star*.

SOME OF THE TEXAS COMPANY'S STOCKHOLDERS ON A VISIT TO PORT ARTHUR WORKS, MARCH 22, 1926

Left to right, top row—R. E. Mossman, H. M. Snyder, Elliott Jones, S. Scarcey, Edgar Park, Mr. Haskell, F. W. Hall, F. P. Dodge, A. L. Beaty (chairman of the board), John T. Scott, Joe Frost, S. C. Fox, H. M. Herron, Travis Holland, W. K. Holmes, M. Halpern, H. A. Fouts.
 Middle row—D. J. Moran (vice president), F. M. Rhodes, H. G. Lapham (see page 339), T. J. Donoghue, Sherman Ford, J. H. Lapham.
 Bottom row—T. G. Dellinger, F. T. Manley, F. J. Shepard, Albert Rockwell, R. C. Holmes (president), W. J. Deady, C. C. Blackman, E. R. Davis, Murry Titus, R. J. Dearborn, R. L. Drake.

of the Southwestern Petroleum Co. with 7,000 bbls. daily production without public financing or issuance of stock although the net cost approximated \$11,000,000.† With a good grip on foreign and domestic trade and with working capital (current assets minus current liabilities) close to \$125,000,000, the company is advantageously situated for further absorptions. Its stock has been very steady on the market, low of 1925 being 42¾ and high, 55; highest price since 1919 being reached on June 23, 1926, when it stood at 56, 124 percent above par. At this rate the 6,578,000 shares should be worth \$368,368,000. No wonder that the new Texas corporation is justified on the basis of \$250,000,000 capital so as to provide for a stock dividend after November 1, 1926.‡ Net income for 1926 was \$36,000,000.



D. J. MORAN

A Vice President of the Texas Co. Since March 18, 1924

He is a native of Ohio and a graduate of Case School of Applied Science (at Cleveland). He has been with this company since 1908, the time of the Glenn Pool excitement. Previously he had been attached to the Buckeye Pipe Line Co., Ohio Oil Co., and Oklahoma Iron Works. In 1920 he became vice president and general manager of The Texas Co. of Mexico.

A. L. Beaty is chairman; R. C. Holmes, president; T. J. Donoghue, G. L. Noble, C. N. Scott, W. W. Bruce, vice presidents; C. P. Dodge, secretary; C. E. Woodbridge, treasurer.

A QUARTET OF MONEY-MAKERS—TWO STANDARDS, TWO INDEPENDENTS

Combined Assets and Earnings. Many oil companies evidenced their highest earnings in 1925 in contrast with the low ones in the lean years 1921 and 1923. Of the four compared herewith, Standard of Indiana is the oldest, having been organized a dozen years ahead of the two independents, Gulf Refining and The Texas Co.'s forerunner. The collective gross income of these three and Humble Oil and Refining Co. probably totaled between 800 and 900 million dollars in 1925. Their net profits aggregated \$150,000,000 out of which \$51,000,000 was paid in dividends, leaving almost \$100,000,000 for surplus addition. The accumulated surplus of all four actually exceeds the cost of the Panama Canal. Assets on December 31, 1925, totaled \$1,534,000,000 or 10 times the net profits.

COMPARISON OF PROFITS, DIVIDENDS, SURPLUS AND ASSETS FOR 1925 IN MILLIONS

	Stand., Ind.	The Texas	Gulf Oil	Humble
Net profits	\$52.9	\$39.6	\$35.0	\$22.6
Dividends	22.5	19.7	6.6	2.1
Surplus for addition.....	\$30.4	\$19.9	\$28.4	\$20.5
Total surplus, Dec. 31.....	\$142.1	\$113.5	\$108.0	\$50.8
Total assets, Dec. 31.....	(a)451.8	397.6	427.6	(a)256.9

(a) Accumulated depletion and depreciation reserves for Standard Oil of Ind. and for Humble Oil & Refining Co. have been added to their assets appearing in official statements in order that comparison may be made with the Gulf and The Texas companies on the same basis. Much of this matter has been abstracted from *Barron's* for March 29, 1926, and supplemented with additional data.

† *Barron's*, June 14, 1926. ‡ *Wall Street Journal*, August 28, 1926.

Comparison of Capital and Earning Rate. The par value, \$25 a share, is the same for all, but the number of issued shares is different. Both Gulf and Humble carry funded debt as part of their capital liabilities, and until 1926 Humble owed the additional sum of \$31,000,000 (to Standard of N. J.) now cancelled through the issue of new stock, bringing its total up to 3,000,000 shares. On December 31, 1925, capital and surplus liability for each was as follows *in millions*:

	Stand., Ind.	The Texas	Gulf Oil	Humble Oil
Number of shares issued.....	9.08	6.58	4.4	1.75
Value of shares issued (par).....	\$226.3	\$164.45	\$109.77	\$43.75
Bonds and notes.....	none	none	42.90	56.00
Total capital liability.....	\$226.3	\$164.45	\$152.67	\$99.75
Capital surplus.....	(a) 63.1	113.47	107.96	50.8
Capital and surplus.....	\$289.4	\$277.92	\$260.63	\$150.55

(a) Besides \$79,970,000 earned surplus, making total surplus \$142,070,000.

COMPARISON OF THE PER SHARE BASIS FOR THE YEAR 1925

Net profit per share.....	\$5.84	\$6.02	\$7.97	\$12.93
Dividends per share.....	2.50	3.00	1.50	1.20
New surplus per share.....	3.34	3.02	6.47	11.73
Total surplus per share.....	15.70	17.25	24.59	29.05
Total assets per share.....	50.00	60.00	97.00	146.00
Earned on invested capital (a).....	11.7%	10.0%	8.2%	8.8%
Earned on capital stock (b).....	23.4%	24.0%	31.8%	52.0%

(a) Total assets considered as invested capital. (b) Par value of issued stock, thus exclusive of borrowed capital. On total capital Gulf earned 23 percent, Humble 22.7 percent, or less than the The Texas rate. The authorized capital of the new Texas Co. of Del. (1926) is \$250,000,000.

A NEW WORLD POWER IN PETROLEUM

Marvelous Growth of the Great Gasoline Marketer. Incorporated in 1889, the Standard Oil Co. of Indiana, directed by Colonel Stewart and Doctor Burton (Chap. XII), has become both powerful and popular, a rare combination. Its original capital of \$500,000 was successively increased to \$1,000,000 (1892), \$30,000,000 (1912), and \$75,000,000 (December, 1920) plus \$37,360,455 additional (June, 1921) for completing the purchase of Midwest Refining, leading Wyoming producer. During 1923 the capital issue stood at \$221,700,000. In two years it gained less than \$5,000,000 notwithstanding the quasi-acquisition of Pan American (Eastern) in March, 1925. Assets of the latter have been conservatively estimated at \$250,000,000 exclusive of which Standard of Indiana possessed in varied resources \$406,000,000 on January 1, 1926, making a marvelous enrichment in 37 years. It is recognized now as the dominant domestic marketer of motor fuel (map, 116).

Properties and Production. Gaining a great interest* and managerial control in the Pan Am. Petroleum & Transport Co. has given Standard of Indiana an influential international position with over 1,500,000 acres of oil lands in Mexico alone, a daily output of about 225,000 bbls. (Mexico, 140,000 potential; Venezuela, over 35,000), a tanker fleet of 3,000,000 bbls. capacity, and American and foreign refineries with 300,000 bbls. daily. Through its Wyoming subsidiary it controls 80 percent of the Salt Creek high grade oil besides much undeveloped acreage throughout the Rocky Mountain states.

* Control only of Class A voting stock of Pan Am. P. & T. Co. (50.2 percent of \$50,077,800 issued. There is also outstanding \$52,977,175 of Class B common). Voting control is held by a syndicate headed by Stand. of Ind., but in which Chase Securities, Blair & Co., and English steamship interests participate.



—*Rig and Reel Magazine.*

PART OF THE GREAT SALT CREEK FIELD IN NATRONA COUNTY, WYO.

Uncle Sam, richest royalty owner, receives as high as $33\frac{1}{3}$ percent of the oil produced from remarkably settled source of light oil. Subsidiaries of the Standard Oil Co. of Indiana control most of the output which in December, 1926, was proceeding at the daily rate of over 40,000 bbls., with two sands held in reserve.

Through Dixie Oil it operates in Smackover, the Pine Island field in Louisiana, the Papoose and Wewoka field in Oklahoma and in various parts of southern Texas. It has access to further supplies of crude through its 50 percent ownership in the Sinclair Pipe Line and the Sinclair Oil Purchasing Co. It has the largest investment (\$60,000,000) in distributing plants, service stations and auto equipment of any oil company. Burton cracking stills† have proven a potent factor in the company's profitable operations.

Standing Among the Standards. If the output of Mexican Petroleum and Lago (in Venez.) be claimed in full, then Standard of Indiana in yield of crude oil through all its subsidiaries measures up well with Standard of N. J., which produced 72 million bbls. in 1925 and ranks ahead of Standard of Calif., which produced 53 million that year. Its domestic production, however, makes but 30 percent of its total whereas 55 percent of the N. J. Standard's is of domestic derivation and practically all of the California Standard's comes from one source, a single state. In *thousands of barrels* daily refining capacity the leaders rank as follows: Standard, N. J., 380; Standard, Ind. (including Pan American's topping plant at Tampico, Mex., and refinery at Destrehan, La.), 300,000; Standard, Calif., 225; Standard, N. Y., 153.5; Atlantic Refining, 66; Humble Oil & Refining, 60; Vacuum, 18.‡ The table below makes financial comparisons in millions:

† Burton patent rights, leased to various Standards and to Tide Water Associated, has brought royalty income so large that five years ago these rights were appraised at \$150,000,000 although not carried as an asset on the books.

‡ Imperial Oil, Ltd., is the Canadian subsidiary of Standard, N. J. It has a daily refining capacity of 45,500 bbls. Its 6,491,852 shares had a market value of \$234,500,000 on May 24, 1926. It owns 54 percent of the stock in the International Pet. Co., Ltd., worth \$228,500,000 on the same date. Its potential yield of crude, middle of 1926, was 45,000 bbls. in Colombia and 30,000 in Peru per day. Since Standard of N. Y. acquired 10 tankers through its absorption of General Petroleum, the number of these owned in 1926 were as follows: Stand., N. J., 52; Stand., N. Y., 43; Stand., Ind., 31 (Pan American controlled); Atlantic R., 14. (Standard of N. Y. had 185,000 bbls. refinery capacity at end of 1926, according to Wall Street Journal, January 12, 1927.)

Companies	Inven- tories	Total assets	Securi- ties	Companies	Inven- tories	Total assets	Securi- ties
Standard, N. J.	\$247	\$1,369	\$1,142	Humble O. & R.	\$48	\$168	\$215
Standard, Calif.	68.6	567	713	Prairie O. & G.	72	154	130
Standard, Ind.	66.1	406	570	Ohio Oil.	30.5	100	140
Standard, N. Y.	149	533	480	Atlantic Rfg.	36	134	109
Vacuum Oil.	32.7	144.5	251	Standard, Ky.	8.1	44.5	80

(Note: Inventories and total assets as of Dec. 31, 1925; market value of bonds and stocks as of May 24, 1926.)

From tables under "Income and Net Profits of Leading Operators" on a preceding page it appears that Standard of Indiana compares best with the others on earning basis, having been second among all operators in total net for at least three years while leading all the "Big Four" in point of net profits per share. In the matter of dividends this producer paid even more than Standard of N. J. *on common* in 1925, namely \$22,500,000. The total of \$33,000,000 in 1926 will be but \$2,000,000 under S. O. of N. J.'s total at its current rate of dividend payments.*

Outstanding Features of Indiana Standard. Maintaining a safe surplus (\$142,000,000, January 1, 1926), this company *has never resorted to public financing*. It has been generous in encouraging employe ownership of stock as well as in disbursing dividends. It is likely the largest income-taxpayer in the Middle West outside of Detroit, its \$4,260,000 support of the Federal Government in 1925 comparing with \$16,493,000 paid by the Ford Motor Co., \$11,000,000 by the U. S. Steel Corp., and \$5,600,000 by General Motors. Standard of Indiana's growth has been extraordinary and its strength has been generally underestimated. It is now the foremost marketer not only in gasoline but also in fuel oil. It owns three-fourths of the 500 to 700 million bbls. reserves in the Salt Creek field (Wyo.) besides controlling probably more than 1,000 million bbls. unmined heavy petroleum in Mexico and Venezuela. The Burton rights might be conservatively capitalized at \$250,000,000, but the company does not publish a consolidated balance sheet showing the hidden strength in its semi-subsidaries, not the least important of which is Lago Petroleum (through Pan American).† Standard of Indiana "perfected a cracking process (the Burton) by means of which the supply of gasoline from a barrel of crude was greatly increased, gave it to the world on generous terms, and by this means acted as a potent force in keeping the price of gasoline down to a reasonable basis as well as in relieving the fear of a failure in adequate supply,"‡

GULF AND HUMBLE—GREAT CRUDE PRODUCERS

A Quarter Century of Gulf Companies. Gulf production was originally formed as the J. M. Guffey Petroleum Co. in Texas, May 16, 1901, following the Lucas discovery (pp. 40-41). The name was changed in 1915. Gulf Refining was incorporated November 26, 1901, before building plants at

* *Wall Street Journal*, August 16, 1926. Net income of \$55,000,000 in 1926 nearly equaled that of the Standard of California.

† Referring to the control acquired of Pan Am. Petroleum & Transport Co., *Wall Street Journal*, December, 1925, quoted Chairman Robt. W. Stewart: "Through the acquisition of great producing properties and of remarkable facilities of transport, the last 12 months have seen us bulwark the foundation of our industrial home and raise its superstructure to such heights that the industrial edifice of no other oil company in all the world may look down upon it." Re. "Iso-Vis," new motor oil, see *Wall Street Journal*, October 30, 1926.

‡ *Oil Trade*, October, 1924, also quoting Colonel Stewart.

Port Arthur, Fort Worth and (1926) Bayonne (N. J.). Gypsy Oil has grown up since 1907 in Oklahoma where it led all others by 2,000,000 bbls. in 1924. The parent corporation, Gulf Oil (of Pa.) was created in 1922 with \$120,000,000 authorized capital, succeeding its name-sake, Gulf Oil Corp. (of N. J., 1907) in control of the three named above and these subsidiaries: Gulf Pipe Line (1906), Gulf P. L. of Okla. (1909), G. Refining of La. (1905), Mexican G. Oil (1912), and Venezuela G. Oil (1923). Gulf Oil, through G. Refining and the lesser concerns, has enjoyed a career of continuous success under the 90-percent ownership by the Mellon family. Much of this is due to the ability of an engineer, President Geo. S. Davison * of the G. Refining. Unfettered by geographic limits, Gulf Oil has steadily fed crude to its huge Gulf Coast refinery by going outside of its birthplace and into the Mid-Continent, California, Mexico and South America. (For view of its Port Arthur refinery see page 137.)

Position in Production and Refining. While Humble has stood highest among crude producers in Arkansas, Louisiana and Texas,† Gulf was first in total domestic production before the merger of Pacific Oil with Standard of Calif. Its 40 million bbls. in 1922 made 7.1 percent of the national total that year. At the middle of 1926, due in part to Spindle Top deep development, the Gulf Oil daily rate of foreign and domestic production combined did not lag far behind that of Standard of N. J. (200,000 bbls.) or the domestic rate of Standard of California (185,000 potential). In refining capacity it approaches The Texas (160,000 bbls. daily) with the 1926 completion of its Bayonne plant (20,000), bringing the total to 145,000 bbls.



—Courtesy Gulf Refining Co.

* President also of the American Society of Civil Engineers during 1926.

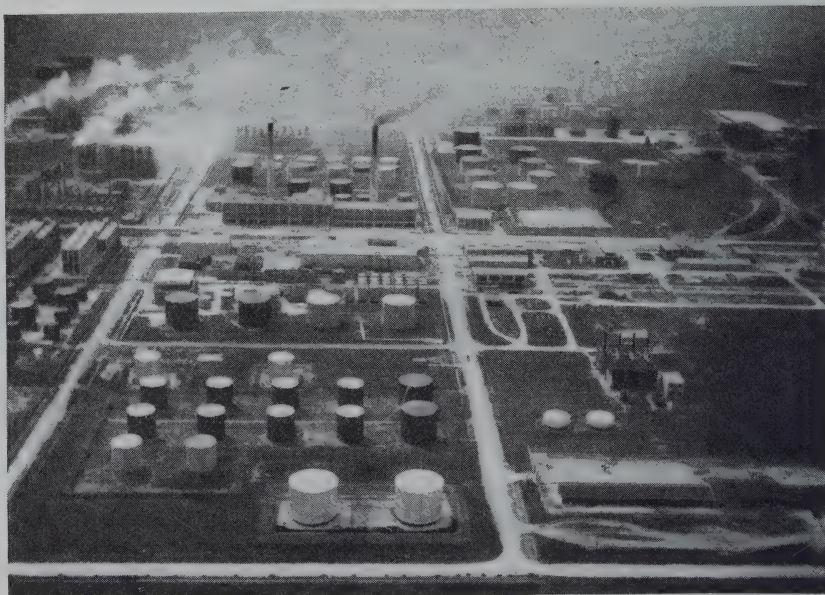
† In these three states Gulf averaged 110,000 bbls. daily during week ended August 28, 1926, breaking its own record for domestic production outside of Oklahoma.—*Wall Street Journal*, September 4, 1926. In combined U. S., Venez. and Mex. output Gulf passed the 210,000 daily mark late in 1926, according to the Philadelphia manager, R. E. Garrett. Read "Gulf Oil Shows Marked Expansion," *Wall Street Journal*, January 12, 1927.

Other independents comparing with it are Tide Water Associated (95,000 complete, 30,000 topping) and the Union Oil of Calif. (37,500 complete, 64,000 other). Gulf led in the Texas marketing of gasoline, summer of 1926. It passed the 210,000 mark in daily crude at end of 1926.

Financial Positions of Gulf and Humble. Both distinguished themselves in 1925, respectively among independents and Standards. In net available for dividends and surplus only one other independent surpassed Gulf with its \$35,000,000. In net profit per share, Humble with \$12.93 led all Standards, even South Penn. (\$11.87), Atlantic Refining (\$11.53), Standard of Ky. (\$10.62), and Vacuum Oil (\$9.74). The profit percentage on par, Humble 52 and Gulf 31.8, was the highest respectively among Standards and the important independents. Humble ranked fifth in total assets and sixth in merchandise (inventories) as shown in a preceding table. Gulf outranked all in its class in total assets and was second in merchandise assets as seen from the following figures, as of January 1, 1926:

Independents	All			Independents	All		
	Mdse.	Cash	assets		Mdse.	Cash	assets
Gulf Oil Corp.....	\$67	\$12	\$423	Union Oil of Calif.....	\$33.5	\$6.9	\$244
The Texas Company.....	94	18.8	393	Tide Water Assoc.....	35.1	19.1	236
Sinclair Consol.....	27.6	5.6	352	Pure Oil.....	15.7	3.1	219
Shell Union.....	22.6	5.8	332	Phillips Petroleum.....	10.3	7.2	130
Empire Gas & Fuel.....	9.0	...	297	Marland Oil.....	8.5	5.0	93

(Note: The assets of the Associated and Tide Water Companies are here combined although the merger did not materialize before March, 1926. Pan American Petroleum & Transport Co. occupies an anomalous position, being independent in ownership but controlled in operation by Standard of Indiana. Its merchandise—stocks of crude and refined oils—on January 1, 1926, were worth \$13,000,000, cash on hand was \$22,000,000 and total assets, \$189,000,000. The figures in the table above represent millions of dollars.)



—Courtesy Humble Oil & Refining Co.

A MODERN GULF COAST REFINERY NEAR HOUSTON

Baytown plant of the Humble Oil & Refining Co. Since it was built in 1921 it has been enlarged to a capacity of 50,000 bbls. daily—over half the total for the Houston district, second in Texas only to the Beaumont district. Humble earned almost \$19,400,000 net in 1926, compared with \$22,620,000 in 1925.

Humble Oil & Refining, capitalized at \$43,750,000 in stocks and \$25,000,000 in bonds, besides a borrowing of \$31,000,000 (from Standard of N. J., refunded through sale in March, 1926, of 1,250,000 share of \$25 par) at the beginning of 1926 had aggregate assets two-thirds greater than the total of the three liabilities just listed. Its inventories, chiefly in crude oil, exceeded by 10 percent its capital stock. It was thus similar to General Petroleum which early in 1925 had 15 million bbls. of crude and refined worth about \$40,000,000, or much more than the par value of its common and preferred (totaling about \$30,000,000). Humble's production is the principal source of the 200,000 bbls. daily crude capacity credited to Standard of N. J., which owns about 70 percent of Humble's issued stock. The record for a single company's 24-hour output from one pool or field was achieved by Humble at the middle of October, 1923, when in one day it obtained 104,370 bbls. at Powell, Tex.*



**UNION OIL COMPANY'S BIG
OFFICE BUILDING IN
LOS ANGELES**

More oil operators than mining companies own their homes. Substantial structures also in San Francisco, Houston, Tulsa, Baltimore Philadelphia and New York have been erected during a decade out of surplus earned by oil companies.

Union Oil officials in 1926: Pres., W. L. Stewart; vice pres., E. W. Clark (in 1927 pres. A. P. I.), W. W. Orcutt, L. P. St. Clair; comptrollers, R. D. Matthews, R. S. Mill, G. H. Forster; secy., J. McPeak; asst. secy., W. R. Edwards; treas., R. J. Keown; asst. treas., J. M. Rust.

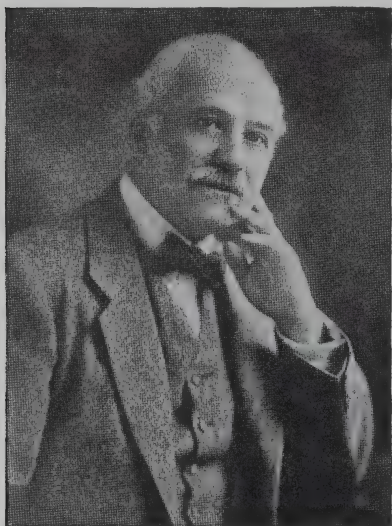
—Union Oil Bulletin.

SOME OTHER SUBSTANTIAL OIL COMPANIES

Union Oil Co. of Calif. This is the strongest unappropriated independent on the Pacific Coast. In value of assets, as shown in table above, it ranks sixth among American independents. Despite the \$3,000,000 net fire loss and excluding \$22,500,000 appreciation due to new discoveries, particularly in Colorado, assets on March 31, 1926, totaled \$265,400,000. Founded by Lyman Stewart, a native of Titusville, this company drilled its first well in 1883. Since then it has discovered 5 of the world's greatest oil fields and has pioneered important steps in oil progress (page 96). It built the

* *The Oil Weekly*, October 20, 1923. See also *Wall Street Journal*, March 5 and May 6, 1925. For additional data on Gulf Oil see *Barron's*, March 29, and *Wall Street Journal*, March 18 and 19, 1926. Gulf Oil had over 40,000 daily from the deepened Spindle Top, September, 1926.

first refinery, laid the first pipe line to tidewater and ordered the first oil tanker built on the Pacific Coast. The company's growth has been splendid, sales rising from \$27,750,000 in 1916, to nearly \$75,000,000 in 1925. The decade's average net profit was over \$9,400,000 per annum. Net for 1926 is at the annual rate of \$12,400,000. It therefore promises to exceed the 1925 rate of 11 percent on par or \$2.78 per share (see earlier page under "Income and Profits of Leading Operators"). Union Oil is in first-class financial shape with working capital of about \$50,000,000, quick assets being fully 7 times current liabilities (see table, end of chapter).*



SIR HENRY W. R. DETERDING

Chairman of the board, Shell-Union Oil Corp., and managing director, Royal Dutch Petroleum Co., Ltd. (of The Hague, Holland).

Sir Deterding is one of the most distinguished men in international oildom. In the management of the American subsidiary of the Royal Dutch-Shell he is associated with Gen. Avery D. Andrews Sir Robert Waley-Cohen, and Samuel M. Vauclain, the great American builder and marketer of (Baldwin) locomotives.

In an address at New York, August, 1926, Sir D. advised against the refinery practice of widening the naphtha fraction at the expense of kerosene for which profitable sales are growing.

Net income of the Royal Dutch and "Shell" companies in 1925 exceeded \$60,400,000, or \$7,500,000 more than that of the Standard of Ind., second American oil company.—*The Oil Trade*, now *Fuel Oil*.

Shell Union Oil Corp. was created in February, 1922, as a consolidation of all the producing and refining properties in the United States (except the New Orleans Rfg. Co.) owned by the Royal Dutch-Shell; also certain interests not controlled by that combine. Of the original 8,000,000 non par common stock, 72 percent went to the Royal D-S and 28 percent to the Union Oil Co. of Del., which held 26 percent interest in the Union Oil of Calif. In 1923 the common was increased to 10,000,000 shares, all issued. Of the 200,000 preferred 6 percent stock of \$100 par value, about 87 percent was outstanding May 24, 1926. Total market value of both was then \$268,400,000, or \$77,000,000 more than the bonds and stocks of Union Oil Co. of Calif.† The recent rise in the price of its shares reflects the fact that its

* See *Barron's*, June 21, 1926, and *Wall Street Journal*, July 10. The 1926 "Petroleum Register" (published by H. S. Reavis, 40 Rector St., New York), contains the following on page 159: "Union Oil is known on three continents. It has devoted 40 years to developing Union Non-Detonating Gasoline and Aristo Motor Oil. * * * Union Oil backs its gasoline and oil with one of the most complete organizations in America today. It has 700 producing wells, 75,000 bbls. of crude a day, 6 huge refineries (see under "Gulf and Humble" on a preceding page), 13 deep sea tankers, 900 miles of pipe line, 500 service stations and 300 distributing plants (p. 92). See also index under Union Oil, Lyman Stewart and W. W. Orcutt; also E. W. Clark, president of the A. P. I. in 1927.

† Shell Union common was worth \$25 on May 24, 1926, and three months later reached a new high of \$29½, making the total market value of its securities over \$313,000,000 about August 22, 1926.

net profit of \$17,240,000 for the first half of 1926 came within \$3,175,000 of its total for the entire year 1925. In value of assets this Dutch-English concern ranks fourth according to a preceding table. These are mainly the properties of its two principal subsidiaries, Roxana Petroleum in the Mid-Continent, and Shell Co. of Calif. on the Pacific Coast. Through these and aside from its half interest in Comar Oil Co. (discoverer of the Tonkawa pool) it has increased its daily crude production from 35,000 bbls. in early 1922 to an average of 116,000 bbls. in 1925 or 45 percent of the entire Royal Dutch-Shell group's world output. In the same time refinery capacity was expanded to 105,000 bbls.* Two of the most profitable investments of Shell Union have been the half-interest in Comar (which has been a leader in Oklahoma since its discovery of Tonkawa) and the 26.77 percent interest in Union Oil of Calif. which it sold in 1923 at a profit of \$6,000,000. The splendid profits of 1926 may be attributed to the company's marketing ability although crude yield has been almost stationary (totaling about 135 million bbls., 1923-1926). Its fine financial position at the end of 1925 was revealed by a net working capital of over \$54,000,000, its current assets being 6.3 times current liabilities of \$10,300,000. The chairman of Shell Union is Sir Henri W. A. Deterding and the president is J. C. Van Eck. Among the directors are Richard Airey and Samuel Vauclain.

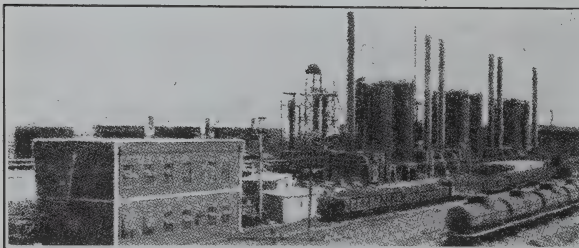
Pan American Petroleum & Transport Co., producing principally through Mexican Petroleum Co., Ltd., of Del., obtained 4 million bbls. more crude in 1925 than Shell Union. This large holding company was controlled by E. L. Doheny and associates up to March, 1925, when Standard of Indiana procured working control, as stated elsewhere. In light crude alone it had a potential of 150,000 bbls. daily in October, 1926. Its reserves are enormous. Of its \$27,335,000 net profit in 1925, about 73 percent was earned by Mexican Petroleum, Ltd. The latter increased its production to 37,370,000 bbls. or 8,122,000 more than in 1924. Other reasons for the financial improvement of this huge producer of fuel oil were more stable prices and expanded market aided by association with Standard of Ind. Its tanker fleet of 2,250,000 bbls. capacity is second only to that of Standard of N. J. Aside from "Mex. Pete" (chief Latin Am. producer) Pan American operates in Arkansas markets through subsidiaries in southern states and in South America, and owns 60 percent in American Oil Co. (retailing along the Atlantic), and 51 percent of the common stock in Lago Oil & Transport Co. (producing Venezuelan oil for the New Orleans or Destrehan refinery).

Pan-American Western Petroleum Co. (inc. Del., 1924) on May 1, 1925, obtained the California properties of Pan-American Petroleum & Transport Co. for \$23,000,000, half cash and half 15-year 6 percent notes. Assets included 26,750 acres in fee or leaseholds, production exceeding 11,000 bbls. daily, a 65,000-bbl. refinery, storage for nearly 9 million bbls., a

* Since the end of 1925 the refining capacity must have materially improved. Shell Co., of Calif., alone was reported to have 110,000 bbls. capacity in the fall of 1926, ranking next to Standard Oil of Calif. with 225,000 bbls., and ahead of these other California refiners: Union Oil, 101,400; Associated Oil, 81,500; General Petroleum (Stand. of N. Y.), 75,500; Pan American Western, 65,000; California Petroleum, 35,700; Richfield Oil, 31,500.

See *Barron's*, September 6; *Wall Street Journal*, July 31 and August 14, *Oil & Gas Journal*, August 5, 1926. On Royal Dutch-Shell, which through Shell Union has 13 percent of U. S. crude output, see *Oil & Gas Journal*, July 22, or *Wall Street Journal*, July 31, 1926.

modern marine loading station with loading capacity of 10,000 bbls. gasoline or 20,000 bbls. fuel oil *per hour*, 147 miles of pipe lines and extensive distributing and marketing facilities. In 1925 the company produced 6 million bbls. and bought 15.5 millions, largely from Petroleum Securities Co., a personal company of E. L. Doheny. Considered together, the two companies at the middle of 1926 were producing at a daily rate of 32,000 bbls., exceeded by only six other California operators. Although one of the youngest oil companies, Pan-American Western was recently nineteenth in inventories and twenty-ninth in the market value of its bonds and stocks. Net income in 1925 was more than \$4,230,000 compared with gross of nearly \$28,600,000. Net per share was almost double as much in 1925 as in 1924.*



PART OF MARLAND REFINERY AT PONCHA CITY, OKLAHOMA

Showing six Dubbs Crack Units with enlarged reaction chambers but without the usual high towers. Marland's assets gained \$10,000,000 in 1926 with no Federal taxes account of \$36,000,000 deduction from income and surplus.

Marland Oil Makes Marvelous Record. This company was formed in 1920 as a consolidation of Kay County Gas Co. and its subsidiary (M. Oil Co. of Mex.), with M. Refining Co., in 1920. It now owns entirely also the M. Oil Companies of Calif., Colo., Okla. and Tex., as well as the M. Pipe Line Co. and Kansas Osage Gas Co. It controls Reagan County Purchasing, Inc., and has (indirectly) a half interest in Comar Oil (see under "Shell Union"). From 3,750 bbls. net in 1920, daily production has grown to fully 50,000 bbls. (in September, 1926), including some from Mexico. Average in 1925 was 33,000 bbls. Handling altogether 100,000 bbls. daily, Marland has become one of the biggest buyers of Mid-Continent crude. Further gains are forthcoming through its participation in new Texas fields and its own discovery of Seal Beach pool at Long Beach (Calif.). It plans to drill 50 tests in the Hudson Bay Co.'s holdings, prairie provinces, Canada. It is financially strong, with current assets almost 6 times liabilities and total assets approaching \$100,000,000. Rank, 1925, was fifth in net profits among independents. Poor showings in 1923 and 1924 were due to heavy depletion deductions, debt payments, etc.†

Pure Oil Prominent in Surplus. Originally incorporated in Ohio as the Columbus Production Co., the Pure Oil Co. was only 12 years old on April 8, 1926. It already ranks eighth among independents in total assets. In surplus of assets over liabilities—about \$60,000,000 early in 1926—it is surprisingly strong standing next to The Texas and Gulf companies. Strangely, its daily crude yield of 50,000 bbls. exceeded its refining capacity (by 6,000), but that was due to buying Wortham production of

* Re-bond issue of \$15,000,000. See "A Thriving Unit," in *Barron's*, September 6, 1926. Officers: President, E. L. Doheny; vice president, E. L. D., Jr.; secretary, R. M. Sands; treasurer, Fred. Ritter.

† See *Barron's*, February 22, March 8, and June 14, 1926; *Oil & Gas Journal*, July 15 and August 12, 1926; *Wall Street Journal*, February 10, September 3 and 4.

Humphrey's-Boyd Oil Co. in 1925 following heavier purchases (1924) of Humphreys leases in Powell, Mexia and Currie pools and the Humphrey's Pure Oil trunk pipe line 208 miles long. That condition is being remedied by the enlarging (and modernizing) of its Marcus Hook (Phila., Pa.) plant which is but one of its nine refineries located in five states including Minnesota. It owns about 2,700 tank cars and nearly 90 distributing plants besides more than 250 marketing stations in the North Atlantic states, Ohio, West Va., Ind., Wis., Minn., N. Dak., Idaho, Mont., Wash., and Sask. (Can.). It has its own office building and refinery in Germany through Julius Schindler G. m. b. H. at Hamburg; also its eight-story home office building at Columbus. Its net profits of nearly \$13,000,000 in 1925 (fiscal year ended March 31, 1926), gave it sixth rank or next to Marland among independents (see under "Income and Net Profits of Leading Operators"). This sum was 22 percent more than the 1924-25 net and 22 times what it was in 1915. During these 11 years its capital stock investment increased 7-fold.* Headquarters were moved to Chicago in 1926.



THE SUN OIL CO.'S MODERN REFINERY AT MARCUS HOOK, NEAR PHILADELPHIA

*Pure Oil is more or less of a family affair like Gulf Oil, Pan-American Western, and Sun Oil. B. G. Dawes is chairman; H. M. Dawes, president; R. W. McIlvain, W. E. Hutton, C. B. Watson, N. H. Weber, H. N. Cole, C. C. Burr, vice presidents; F. S. Heat, secy.-treas. See *Oil & Gas Journal*, p. 4, October 22, 1920, July 15, 1926; also *Petroleum Age*, December 15, 1924, p. 22, and *Wall Street Journal* May 8, 1926. Late in 1926 it was a leader in the sensational Seminole pool which early in 1927 surpassed Cushing.

Phillips Petroleum—Phenomenal Growth. The world's leading producer of natural gasoline (500,000 gals. daily in August, 1926), was only 9 years old in June, 1926. Total assets grew from \$26,000,000 in 1919 to \$125,000,000 on December 31, 1925. Net earnings increased from \$1,620,000 in 1920, to \$12,330,000 (next to that of Pure Oil) in 1925. During the first half of 1926 net was at an annual rate 35 percent greater than in 1925. Its net daily production of crude reached a new peak of over 61,000 bbls. in August, 1926, 25,000 of it coming from the Burbank field; also additional from the Panhandle and Wilbarger County, Tex. It is sixth among independents in output of petroleum. Daily rate was 75,000 bbls. at end of 1926.†



—Courtesy Atlantic Refining Co.

TYPICAL SCENE IN ONE OF THE PRINCIPAL U. S. OIL PORTS

Crude petroleum leads raw sugar and all other commodities received at the "Quaker City." Refined mineral oil ranks among the first three outgoing articles of commerce, the others being grain and coal. In 1925 oil receipts were over 46 million barrels, 90 percent of which came from the Gulf coast and California. Water shipments, mainly refined oil, aggregated 11 million barrels, 60 percent to foreign countries and by far the major amount by the Atlantic Refining from the Point Breeze plant on the Schuylkill, shown above in part. Gulf Refining is now erecting a modern refinery in this vicinity.

REFINERS AND MARKETERS IN THE PHILADELPHIA DISTRICT

Terminal of Four Pipe Lines. Pure Oil, Crescent (now abandoned), Transit and United State pipe lines have had their terminals at Philadelphia. At present more crude is received by water than otherwise. On the Atlantic Coast the Quaker City has become the foremost refining and marketing center next to Greater New York. Excluding plants on the Jersey side of the Delaware, Philadelphia refineries handle about two-thirds of the oil refined in the state.* The independents are more numerous here than in

† Frank Phillips is president; L. E. Phillips and C. Alexander, vice presidents; H. E. Koopman, secy.-treas. Among the directors are E. E. DuPont and Wm. N. Davis, who is chairman of the Public Relations Committee of the Am. Pet. Inst.

* Capacities of plants in and around Philadelphia are as follows (in thousands of bbls.): Atlantic, 50; Sun Oil, 20; Vacuum, 11; Sinclair, 12; Pure, 5; The Texas, 5; Crew-Levick (on Petty Island), 4. The 2d, 4th, 5th and 6th of these are located at Marcus Hook.

Greater New York. The two Standards are the Atlantic Refining and the Vacuum Oil Co., the former having its home office here in a huge and handsome building. The latter has one of its two minor refineries and its second shipping plant across the river, at Paulsboro; its main plant being at Bayonne, on N. Y. Bay, and its oldest plant at Olean, N. Y.

Atlantic Refining Financially Strong. The most distinctive "Keystone" operator of any size, the Atlantic Refining Co., was incorporated in Pennsylvania in 1870. It took over all Standard Oil business in this state at the time of the dissolution. It owns about all of Atlantic Oil Shipping Co., A. Oil Producing Co., A. R. Co. of Africa, A. Refining Co. of Brazil, A. R. Co. of Italy, and A. Refining & Asphalt Corp., besides Red "C" Oil Co. and Richmond Oil Co. Through the second of these it owns much of Atlantic Lobos and Panuco-Boston, both operating in Mexico, also Gulf Coast Oil Corp. of Texas. Through heavy stock ownership in Superior Oil Corp. it has options on that company's Kentucky output. A one-half working interest is held in Andes Petroleum's large Colombian and Venezuelan holdings. About 20,000 bbls. daily during 1925 was derived mainly from the Mid-Continent and Kentucky. Exclusive of Superior output the daily yield of owned and controlled oil was 22,500 bbls., September, 1926. Refining capacity totals 66,000 bbls. daily from plants at Philadelphia, Franklin, Pittsburgh and Brunswick, Ga. That near the confluence of the Schuylkill and the Delaware (Pt. Breeze), is one of the largest and most modern in the country, covering 676 acres. Marine equipment includes 14 tankers. Distributing stations approximate 350 and service stations 220 in Pa., Mass., Conn., R. I. and Del. Gross operating income in 1925 was \$137,850,000 and in 1926 may exceed \$160,000,000. The 1925 net of \$7,167,000 was the highest since 1920. In the first half of 1926, owing to the higher costs of crude, etc., the spread between cost and return per bbl. of crude processed was reduced to 6.30 cents from 6.63 cents in the first half of 1925. Present low dividend rate reflects a conservative financial policy since the company is lowering its funded debt at the rate of \$4,300,000 yearly.* Surplus, however, stood at \$27,634,000 on December 31, 1925, and may pass the \$30,000,000 mark by 1927 if meantime no stock dividends be declared. The most favorable feature, perhaps, is the unusually high ratio of quick assets to current liabilities, nearly 10 to 1, which is surpassed by only a few companies such as Salt Creek Producers, Ohio Oil and Vacuum Oil.

Sun Oil, Another Substantial Company. This is one of the most complete, conservative, and steadily successful of all American operators. Though not among the "Big Ten" in the oil business, it ranked seventeenth among the independents in the market value of issued securities (\$43,300,000), May 24, 1926. Through Sun Shipbuilding and Dry Dock Co., at Chester, Pa., it turns out its own tankers and other vessels. Its first predecessor was founded in 1886 by Joseph N. Pew, whose association with oil began in 1864.

* The strong financial position of Atlantic Refining is largely due to President J. W. VanDyke, one of the most experienced oil men. Vice presidents include W. M. Irish, W. P. Cutler, R. D. Leonard and W. D. Anderson; Albert Hill is treasurer, E. R. Cox, and Robt. H. Colley, asst. treasurers; W. M. O'Conner, secy., and E. J. Henry, asst. secy. See comparison of Standards in table under "A New World Power in Petroleum."

The present is the highest surplus since previous to the payment of the \$45,000,000 stock dividend in 1922. Although Atlantic Rfg. ranked but 19th in value of its securities, May 24, 1926, and 18th in total assets December 31, 1925, it stood 16th in surplus, 10th in current assets, and 9th in oil inventories.

The present parent company was incorporated in New Jersey in 1901. The president is J. Howard Pew, and among the vice presidents are J. N. Pew, Jr., and J. Edgar Pew (who was honored as the second president of the Am. Pet. Inst.). Production of 5,000,000 bbls. of oil in 1925 came from Texas, Oklahoma, Arkansas, Louisiana and Ohio. Daily capacity of three refineries is 25,000 bbls. Sun lubricants are popular in Latin America, Europe and Africa as well as in all domestic states. Sales have risen from \$8,200,000 in 1914, to \$48,000,000 in 1925. Net earnings averaged over \$3,350,000 annually the past 11 years. Undistributed surplus of only \$3,550,000 on December 31, 1925, evidenced a liberal dividend policy.

Crew-Levick Business Begun in 1862. Acquired by Cities Service Co. in 1916, this company and the Empire Gas & Fuel Co. are the two chief petroleum subsidiaries of the Doherty interests. Nearly 800 small wells in Ohio and Pennsylvania are owned by the Crew-Levick Co., also 3 refineries totaling about 7,000 bbls. daily capacity and located at Titusville, Warren and Petty Island (near Phila.). It pioneered the present retail system. It supplies over 200 communities in Md., Pa., N. J., N. Y., Conn., and Mass. Its assets approximated \$13,000,000 May 31, 1925.

FINANCING THE AMERICAN OIL INDUSTRY

Expansion in Petroleum. An overshadowing movement of 20th century has been the growth of the oil business. According to Edward Prizer the entire petroleum industry employed but \$114,000,000 capital in 1882.* By 1922 this sum had expanded to nearly \$8,000,000,000 and by the end of 1925 to \$10,000,000,000. The value of the crude oil increased from less than 5 million dollars in 1860 to 25 million in 1880, 76 million in 1900, 128 million in 1910, and 1,360 million in 1920. The value of the products advanced as follows: 27 million dollars in 1869, 85 million in 1889, 124 million in 1899, 237 million in 1909, and 1,633 in 1919. It probably approximated 3,000 million dollars in 1925 (wholesale, at refineries).

Sudden Need for New Capital. If the investment increase has been evenly distributed during the 40 years, 1882-1922, the annual rate would have been almost \$200,000,000 or *70 percent more capital each year than was tied up in the entire petroleum business at the end of the first 23 years of its operation.* However, according to Mr. Prizer, this demand for new capital was not gradual but grew suddenly since 1913-1914. At the close of 1925 there were about 16 times as many autos and trucks registered in the United States as on December 31, 1913. Within a dozen years the oil industry has had to meet a 16-fold gain in demand for motor fuel additional to increases in other directions. There is another side to the situation: Enormously greater working capital has been required for the drilling of much deeper wells, the paying of higher bonuses, rentals and wages, and the transportation of petroleum and its products over greater distances.

Current Requirements. The 1925 president of the A. P. I.† estimated the

* Based on Census data; see "We Shall Find the Oil We Need" (through investing capital), by the president of the Vacuum Oil Co. in *Nation's Business*, July, 1923; also, "Financing the Oil Industry," J. J. McGraw, president, Exchange Nat'l Bank, Tulsa, in *The Tulsa Spirit*, October, 1925.

† J. Edgar Pew, pres., Sun-Beacon Oil Co., succeeded in 1926 by W. S. Farish.



—The Oil Weekly.

EDWARD PRIZER

Chairman of the Board, Vacuum Oil Co.

Born at Doylestown, Pa., Mar. 3, 1856, according to "Who's Who in America," he began as reporter on a country newspaper before becoming its business manager. His literary ability has not been lost, as evidenced by his contributions to such particular periodicals as *Nation's Business*. He ventured into oil with the Vacuum Oil Co. at the age of 26. He was promoted to president in 1917, and since 1924 has served as chairman. During the world conflict he worked on the Petroleum War Service Committee, and afterwards was elected vice president of the American Petroleum Institute. Like other Standard men, Mr. Prizer is public spirited. Thus he takes time to act as trustee of the Orange (N. J.) Memorial Hospital.

cost of drilling 24,642 new wells in 1922 at almost \$530,000,000. Because of the increasing depths this capitalized cost must have been about \$700,000,000 in 1925. Add thereto \$550,000,000 as the capital expenditures refining, storage, transportation and marketing facilities brings the total for 1925 to \$1,250,000,000. This is too high considering the huge outlay for cracking units added to established plants, for entirely new refineries, and for innumerable filling stations (some superfluous).

Capital Invested—Comparisons. The total invested in oil and represented by property values early in 1926, approximated \$10,500,000,000* or little more than one-fifth of the 1925 depreciated value of the United States farms and farm buildings. It was 8 percent less than the assessed value of New York City in 1924, and about 5 percent more than all our investments abroad or our combined Federal, state and local taxes in 1925. The sum invested in the United States oil industry exceeded the total stock of money, including gold and bullion, in the United States on April 1, 1926, by over \$2,000,000,000; or by \$1,500,000,000 our foreign trade in 1925, or the ready cash of all American insurance companies. Investments in the production branch alone (about \$4,750,000,000) approximated twice the assets of the U. S. Steel Corporation or twice the present annual rate of capital expenditures by the American railways.

How the Industry Has Been Financed. To quote Banker McGraw, this great industry has financed itself. As late as 1915, oil financing was consid-

* Assets aggregated \$7,411,000,000 in 1920, according to Victor Ross in his "Evolution of the Oil Industry." Of this 48 percent pertained to production and only 11 percent to refining. The author has added \$1,250,000,000 to the 1924 figure of Chas. E. Bowles in *The Oil & Gas Journal*, September 25, 1924. In that for March 20, 1924, N. O. Fanning summarizes the capital investments during the 5-yr. period, 1919-1923; averaging at \$600,000,000 yearly of which \$225,000,000 represents outlay for refineries. Crude and refined inventories of 71 operators on December 31, 1925, totaled \$1,311,000,000 or 46 percent more than the estimate by Bowles in 1924. For details see "Forms in Which Assets Are Found,"

ered by the conservative bankers as too risky to offer their customers. It was risky not only because of the inherent chances of the business itself, but because some men, of not too exact ideas of business honesty, sought to make quick fortunes out of the desire for speculation (see Chap. XIV). But the real producer, the real refiner and the real marketer built up their business out of their profits. Instead of distributing accumulated earnings, these went back into oil properties, extensions of refineries, pipe lines and tank cars, until by sheer force of will and untiring labor the oil business was built solidly upon itself. (1) By so conserving and using their profits, the older companies have been able to expand their business without asking the public to buy their bonds or stocks. * * * (2) Newer companies have asked and obtained capital from the public. N. O. Fanning * estimated that out of \$1,920,000,000 expended during the 5 years to December 31, 1923, for oil facilities other than production, about \$1,000,000,000 or a little more than half was paid out of earnings. During the 14 years since the dissolution decree of 1911, Standard Oil of N. J. invested more than \$766,000,000 in property, but only 26 percent thereof came from the sale of securities (\$200,000,000 of 7 percent preferred stock said to be soon converted into common).

Surplus Serves a Threefold Function. As already shown, some concerns, such as the Atlantic Refining and Gulf Oil, set aside more of the current earnings than they distribute in dividends. Such accumulated surplus may be regarded as a reserve for three purposes: (1) To absorb losses; (2) to meet dividend payments in lean years; (3) to supply new capital for expansion. X Thus, in 1925, N. J. Standard paid 7 percent on preferred out of \$114,000,000 total net earnings and divided the balance between dividends on common (1/5) and surplus (2/5). Its accumulated surplus increased almost \$80,000,000 to about \$350,000,000 on December 31, 1925. Before that, \$566,000,000 had been plowed back into property out of surplus. No wonder that in 1922 there was declared a stock dividend of almost \$398,000,000 (400 percent of the then \$99,500,000 common stock capital) by the greatest of all oil companies.†

Increase in Capital of Old and New Companies. Pogue presents a table showing the enforced expansion of established operators and the enormous growth of new concerns. The capital stock of 250 of the former increased

* Page 157, *The Oil & Gas Journal*, March 20, 1924, and "Financial Problems Successfully Met," May 29; also *Barron's*, May, 1926. See Pogue's "Economics of Petroleum," pp. 9-10.

† See *Barron's*, May 3 and 17, 1926; also *The Wall Street Journal*, September 1, 1925, "Standard Oil Now Building Surplus." Surplus earned in 1925 approximated that of the Ford Motor Co. "Those who envy or decry the profits of business evidenced by surplus do not understand where their own interest lies. The benefits of improved methods and machinery and labor-saving devices, as soon as their use becomes general, accrue far more to the consumers than to the producers. Competition always reduces prices after costs are generally reduced. * * * Stability as well as economy and progress is largely dependent upon the judicious building up of surpluses. * * * Profitable business is the only foundation for material prosperity. Undercapitalized business means that improvements requiring several years to pay for can not be made. This brings high prices for consumers and losses to owners."—Editor Lefevre, *Texaco Star*, March, 1926. Cases in point of self-financing: (1) The Texas Co.'s purchase of the Southwestern Petroleum Co. with over \$11,000,000 cash and short-term notes, spring of 1926; (2) Standard of Calif. in 1920 spent over \$35,000,000 for additions to refineries and marine equipment and for acquisition of producing properties in N. and S. America; (3) Magnolia (Standard of N. Y.), was spending \$30,000,000 in 1926 for betterments and bigger facilities, chiefly in Texas. X 4, to retire bonds.

from 885 million dollars in 1913, to 3,174 million in 1920. That of new oil companies (i. e., those not existing in 1914) grew from 81 million dollars in 1915 to 8,351 million in 1920. But because 5 to 6 billion represented "paper" or "boom" capital and only 5 to 6 billions of capital represented tangibles or real assets, the actual capital absorbed into the oil business to support its legitimate expansion during the period 1913-1920 was between 4 and 5 billion dollars. Contemporaneously, the funds flowing out of the industry as dividends was around 1 billion, leaving from 3 to 4 billion dollars as an approximation of the net amount absorbed.* During 1924, investments in new oil companies alone amounted to \$787,000,000 compared with \$926,400,000 in 1923.**

MAKING MONEY OUT OF MINERAL OIL

Many Ways of Making Money. Under "Earnings of the Entire Industry," near the middle of this chapter, 13 sources of corporation income were enumerated. But the individual investor finds few desirable opportunities devoid of high hazard unless he advises with a genuine geologist or an experienced engineer. The two safest ways of making money are through fee ownership of oil land † and the holding of stock in firmly established companies of the vertical monopoly type. If private land is not for sale in a new oil field perhaps the investor may be able to buy part of the mineral rights of a fraction of the royalty; but he must allow for oildom's law of diminishing returns or he may lose out, particularly if he buys before production becomes settled.‡ The author knows a Texas rancher (p. 123) who not only receives bonuses and royalties as a land owner and income as a stockholder in his operating company, but also makes money out of royalty interests acquired from other lessors. From his own experience he learned not to appraise royalty interests on flush production (see "Making Money Out of Crude Stocks").

Wildcatting Attractive Though Highly Hazardous. About 85 percent of the wildcat "wells" drilled in the United States are failures. According to the discoverer § of the Wewoka pool (fifth largest in Oklahoma, June, 1926),

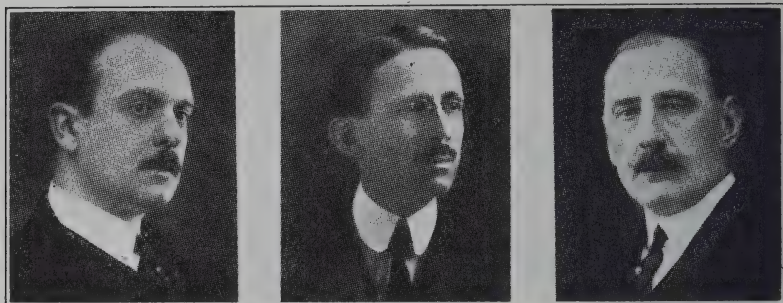
* Page 8, "Economics of Petroleum," John Wiley & Sons, 1921; see also Bowles' "The Oil Business and the Oil Game," *The Oil & Gas Journal*, May 22, 1924, in which he states that "More money was contributed by the public in 6 years to create 5 percent of the oil industry than basic companies raised in 50 years."

** According to *Petroleum World*, Los Angeles, quoted in *Ohio Gas & Oil Men's Journal*, April, 1925. As indicating how assets are overtaking capitalization, Magnolia Petroleum Co. lately increased its capital stock from \$100,000,000 to \$180,000,000 in order to cover its increase in assets. Its properties in Ark., Kans., N. Mex., Okla., and Tex., were valued at \$230,000,000, according to *The Wall Street Journal*, January 4, 1926.

† "Undoubtedly the man who chances to own land on which oil in paying quantity is found is blessed with good fortune, especially under modern conditions whereby fair and generous treatment is assured him. But he contributes nothing to the expensive processes by which the precious liquid is extracted from Mother-Earth, and risks no capital in the experiment."—*The Lamp*, October, 1920, quoting Victor Ross under "America's Investment in Petroleum."

‡ See page 71. It is the preferred policy of some concerns to own oil land outright instead of paying bonuses and royalties. Probably 85 to 90 percent of current output comes from leaseholds and not feeholds.

§ R. H. Smith, pres., The Oklahoma Co., who addressed the Federal Oil Conservation Board, February, 1926. He said that if the Government should discourage legitimate wildcatting the price of oil would pass beyond all reasonable bounds.



—The Lamp.

INTERNATIONAL CHARACTER OF ANDIAN NATIONAL CORPORATION

Three of the directors, left to right—Maurice Boyer, sub-director, Bank of Paris and Netherlands; C. E. Neil, general manager, Royal Bank of Canada; Hon. Hugo Baring, Baring Bros., London. The Andian Pipe Line, about 360 miles long, was built at the record rate of 30 miles per month through the jungle of Colombia at great cost. The capital of \$15,000,000 was raised in Canada, Colombia, Europe and the United States, one of the directors being President Donnell, of the Ohio Oil Co.

it took 4,000 wildcat tests drilled during 25 years to find the 200 pools in Oklahoma. "Barrels of money and plenty of nerve" † are required in the search for oil. Large oil companies will not always reserve for small concerns and innocent and ignorant investors the risks of making dry holes. Thus a 5,130-foot venture of the Standard Oil Co. of California on Wheeler Ridge (page 64) cost \$175,000 before abandoned for a better location. Another dry hole, over 6,000 feet deep, cost the same operator almost \$50 per foot. While fully 90 percent of new oil companies are formed for the purpose of wildcatting, it generally takes more capital than most of them command because of the increasing depths. In fact, this speculative line is no longer regarded as a poor man's game (see under "The Legitimate Wildcatter," Chap. XII, and "How to Win in Wildcatting," Chap. XIV).‡

Profitable Production of Natural Gasoline. In the production of crude oil much money is lost by most small operators, especially in the Appalachian field (see "Margin Between Cost and Market Value," in first half of this chapter). But in recent years a new opportunity has arisen for making money by the minor producer through the less hazardous conservation of gaseous gasoline. In 1911, when casinghead or natural-gas gasoline made up $\frac{3}{4}$ of 1 percent of the motor fuel obtained in the United

* Financing pipe lines and profiting from their operation will be treated in the next annual edition under "Transportation."

† *The Oil and Gas Journal*, September, 1923; idem, August 13, 1926, J. O. Lewis, pet. engr., "Advocates Regulation of Wildcatting."

‡ "To the average man the oil business means the seeking and finding of oil wells. Spectacular incidents surrounding the discovery of new fields * * * are nourishment to the newspapers which print pages about the millions made over night. Well they may, for in no other industry in the work-a-day world is there such enormous reward for a successful undertaking. * * * Great as are the fortunes made by finding oil where not suspected, they are insignificant beside the fortunes made in other branches of the business."—S. O. Andros, pres., Petroleum Extension University, Fort Wayne, Ind. See *Oil and Gas Journal*, May 6, 1926, p. 102, "One of the Few Remaining Poor Man's Fields"; idem, May 22, 1924, "The Oil Business and the Oil Game," by Chas. E. Bowles. Those intending to drill for oil without previous experience should read Press Notice No. 14,117, "Hints on Oil Prospecting," U. S. G. S.; "Business of Oil Production," John Wiley & Sons, \$4.50; E. R. Lilley's "The Oil Industry," D. VanNostrand, 8 Warren St., New York, 1926, \$6.00. The last is highly recommended.

States, only \$2,000,000 was invested in this business. In 1925 the capital amounted to practically \$200,000,000 and the output measured about 30,000,000 bbls. or 11 percent of the total production of gasoline. According to C. O. Wilson the production of natural gasoline has become a major industry. In fact, one of the most prosperous and fast growing of the leading operators (Phillips Petroleum) bases its success on this branch in which it is foremost with one-eighth of the total yield in 1925. Investors, however, are advised against being stampeded into buying stock promiscuously since failures are not infrequent in this youngest branch of the oil business.*

INVESTING IN OIL SECURITIES

Few Bonds and Fewer Borrowings. Possibly fewer than 50 American oil companies have ever issued bonds and probably even fewer borrow money without security. Until rather recently banks looked askance at 99 percent of the oil companies, particularly those confined to the production of crude, let alone the finding of petroleum. Now that the business has become safer through the wider application of geological science and engineering principles and more economical and settled through the reduction of waste, increased recovery and corporate mergings, interest rates have been materially reduced. Thus in 1921, the Vacuum Oil Co. issued \$20,000,000 worth of bonds bearing 7 percent interest and Skelly Oil Co. \$3,500,000 bearing 7½ percent, whereas the same concerns in 1926 could borrow at 5 to 6 percent. That better relations with bankers have been brought about, partly through the stronger cash position of many companies, is evidenced by the increasing number of oil men who have been made bank directors in late years. Thus in 1925 the present chairman of The Texas Co. was elected to the board of the Chase National, one of the three largest banks in the United States.

Bond Liabilities in Force, Middle of 1925. Some of the more important bond issues are listed below. It will be noted that the seven leaders in funded indebtedness were Sinclair Consolidated (total 87.3 million), Gulf Oil (45), General Petroleum (27.3), Atlantic Refining (27.1), Union Oil (25.2), Humble O. & R. (25) and Associated (24). It may be safely assumed that the aggregate petroleum capital represented by bonded liabilities is below \$500,000,000. This sum is small considering that the total new bond financing in 1925 amounted to almost 10 times as much. In October, 1926, California Petroleum offered \$12,000,000 worth of 5½ per-

* *Oil and Gas Journal*, October 8, 1925, estimated total gross revenue in 1925 at \$125,000,000. Within 18 months California invested over \$31,000,000 in new equipment. See "Portable Plants," *idem*, November 19, 1925; also *Oil Trade*, April, 1924, H. J. Struth's "Past, Present and Future of Nat. Gasoline Industry."

"That the casinghead gasoline business is not so attractive as one would imagine is proved by the many dismantled plants and bankrupt gasoline companies in the Mid-Continent. There is considerable advantage in owning oil leases and producing therefrom both crude oil and casinghead gas, using the latter in the manufacture of gasoline in one's own plants. Also, if refineries producing blending material and possessing adequate distributing and marketing facilities are owned and controlled by oil companies, the conditions are conducive to a substantial margin of profit."—*Mining and Metallurgy*, July, 1923.

The author advises investors against encouraging the opening of new filling stations where absolutely not needed. Interlopers in this line are not only opposing the conservation of capital but they are actually increasing the prices of petroleum products which the public must eventually pay. Those who feel justified in entering this branch, especially in out-of-the-way places, will benefit from reading "How to Run a Service Station at a Profit," a valuable handbook for sale at \$3 by *Oil Trade*, 350 Madison Ave., New York.

cent debenture bonds and in November Standard of N. J. \$120,000,000 of 5 percent debentures.

Name of corporation	Amount millions	Interest rate	Maturity ing year	Name of corporation	Amount millions	Interest rate	Maturity ing year
Associated Oil.....	\$24	6	1935	Phillips Petrol.....	\$3.2	7½	1931
Atlantic Rfg.....	12.1	4½	1926-28	Producers & Rfrs...	3.4	8	1931
Atlantic Rfg.....	15	5	1937	Sinclair, Ser. A.....	47.9	7	1937
Barnsdall Corp.....	3.7	8	1931	Sinclair, Ser. B.....	24.4	6½	1938
Galena Signal.....	7.6	6 & 7	1930, '33	Sinclair, Ser. C.....	15	6	1927
General Petroleum...	18	5	1940	Skelly Oil.....	2.8	7½	1931
General Petroleum...	9.3	6	?	Standard, Calif.....	20	5	1926-33
California Petroleum	7.2	6½	1933	Standard, N. Y.....	20	6½	1933
Gulf Oil Corp.....	33	5	1937	Standard, N. Y.....	15	4½	?
Gulf Oil Corp. Ser...	12	5½	1926-28	Sun Oil Co.....	10	5½	1939?
Houston Oil.....	7	6½	1934	Tide Water Oil.....	12	6½	1931
Humble O. & R.....	25	5½	1932	Transcontinental ...	6	7 & 8	1931, '29
Magnolia Petrol.....	15	4½	?	Union Oil, Calif....	16.2	5	1927-35
Mid-Continent	12	6½	1942	Union Oil, Calif....	8.9	6	?
Pan. Am. P. & T....	17.7	6 & 7	?	Valvoline	1.9	7	1937
Pan Am. Western...	11.2	6	1940	White Eagle O. & R.	2.6	5½	?

Significance and Safety Feature. Any bond fit for the average investor is a mortgage upon property. All the assets of an oil company, as a rule, are worth much more than the total face value of its bonds. Those of the Associated, December 31, 1925, were 5 times the bonded obligation; Atlantic Refining, 5.6 times; Humble Oil & Rfg., 6.7; Gulf Oil, 9.9; Phillips Petroleum, 40; Sinclair Consol., 3.9; Standard of Calif., 18.7; Standard of N. Y., 15.2; Tide Water, 8.2; Union Oil, 10. The Texas Co. and most of the Standards have no bonded debt. Standard of Ind. owns half of the Sinclair Crude Oil Purchasing Co., which in January, 1925, issued \$50,000,000 of 3-year 6 percent bonds; also half of the Sinclair Pipe Line Co., which has \$20,000,000 of 20-year 5 percent gold bonds outstanding. To offset the greater safety of bonds compared with stocks the investor must understand that stockholders have voting power and bondholders none. If the stockholders, indirectly, mismanage an enterprise and lose money, the safety of the bonds depends upon what is left; hence the advantage of a high ratio between assets and bond liabilities.*

Principles in Buying Bonds and Stocks. Obviously, an oil company's mortgage bonds are safer than its debenture bonds and preferred stock, and the last is in turn not so risky as its common which, however, is not limited in earning power to any indicated rate of interest (see table of net profits). Although the *rate* is fixed for bonds and preferred stocks, their *yield* depends upon the price paid for them, whether above or below par. Thus, if a \$100 bond bearing 6 percent interest were bought at 90 percent of par it would yield $6 \times 100 \div 90$, or $6 \frac{2}{3}$ percent on the investment. Nine rigorous tests in buying an industrial bond are listed by *Barron's*: (1) It must be secured by a mortgage (leaves out debentures, however good); (2) earnings must equal at least twice the fixed charges; (3) trend of earnings during a 5-year period must be upwards; (4) bond must mature within 25 years; (5) stockholders must consider their equity at minimum within 5 years at not less than the funded debt; (6) if a closed mortgage is not behind the bond, additional bonds should not be issued for more than 50 percent of the net cost of additions and improvements; (7) net quick assets should at least equal the funded debt; (8) as to size, company should have

* See "Safety in Industrial Bonds," *Barron's* for May 24, 1926; "Elements of Bond Investment," by A. M. Sakolski, The Ronald Press, New York; "Jordan on Investments" (p. 105), Prentice-Hall, Inc., New York.

outstanding securities of fully \$10,000,000; (9) some of these should be listed on the N. Y. stock exchange.

Investing Versus Speculating. Most investors regard the earning power more vital than the safety features and so prefer to buy common stock. They are willing to run a larger risk for more liberal return. Net on par may vary from 5 to 8 percent on preferred and generally from 6 to even 50 percent on common (see Humble, 1925). Common is attractive not only because of current profit realized through dividends but also because of possible increment in market value of this stock due to additions to assets. A man *invests* if he looks primarily to the preservation or safety of what he already has; he *speculates* if he aims at profits or yield, risking what he has to that end. To be classed as an investment, according to the Better Business Bureau,* any security should possess three cardinal qualities: (A) Safety of principal; (B) satisfactory income and (C) saleability. After testing for these traits the buyer of bonds or stocks should consider their *suitability* for his particular purpose.

Quality Testing Before Investing. Legitimate and honestly managed though an oil enterprise may be, it must be considered more or less speculative unless its bonds and stocks stand the tests for the qualities mentioned. Under (A) the first to consider is (1) "Security in securities—the preservation of capital already owned; next, (2) capitalization should bear a conservative relation to assets and past earnings should have paid fixed charges (working costs, debt interest, etc.) with easy margins; (3) men in the management both of the oil company and the house selling the securities should have a reputation for ability and integrity. Under (B) the buyer should have in mind (1) the regularity or permanency of the dividend payments or the interest income; (2) the rate of return on the market price he is paying; (3) the distinction between bonds and stocks in that a corporation is definitely and legally obliged to pay interest periodically on the former (excepting income bonds but including corporate notes classed with bonds), but may withhold dividend payments whenever warranted by good policy; (4) a safe surplus of earnings above interest and dividend demands in normal years so as to provide funds for future years that may be lean. Under (C), saleability, one should realize (1) the advantage of converting an investment into cash when needed; (2) what a fair price is so as not to accept bids 5 or 10 points below the reasonable price just because there may be an immediate buyer; (3) what an open market is, in which the public actively buys and sells securities.†

SHARES OF ESTABLISHED OIL COMPANIES

Sixteen Best Sellers in 1925. The following table represents a rearrangement of statistics published in *The Wall Street Journal* with the addition

* "How to Invest Your Money," issued by the B. B. B., 280 Broadway, New York (D. F. Houston, chairman; Bayard Dominick, pres.). Obtainable from H. L. Doherty & Co., 801 Union Nat'l Bank, Pittsburgh, or from locals of the B. B. B., as at 808 Public Ledger Bldg., Philadelphia. This organization is affiliated with the Assoc. Advertising Clubs of the World (page 106, f. n.), with which the author conferred before withdrawing in 1923 from the U. S. Treasury Department so as to prepare this oil book. Read "Investment versus Speculation," *The Texaco Star*, May, 1922.

† As to *suitability*, there are 12 tests which will be described in detail in the author's forthcoming book "Oil Finance and Investments."

of columns for par value and approximate dividend yield based on the last 1925 market quotation.

TRANSACTIONS IN PETROLEUM STOCKS, NEW YORK, 1925

Thousand shares sold	Description of securities	Par value	Range of prices			Dividends	
			High	Low	Last	Amount	Yield %
6,937	Pan American P. & T. "B"....	\$50	\$84½	\$60¼	\$77¾	\$6	8
5,732	Marland Oil	no	60½	32½	59¼	4	6.7
3,934	Pacific Oil	no	78½	51½	75¾	3	4
3,791	Independent Oil & Gas.....	no	41¾	13½	32¾	5	15
3,760	Phillips Petroleum	no	47½	36¼	46½	3	6.5
3,110	General Petroleum	25	59½	42	58¾	3	5.1
3,082	Standard Oil of N. J. (com)...	25	47½	38¾	46	1	2.2
3,018	California Petroleum	25	34¾	23½	34	2	6
2,991	The Texas Company	25	55	42¾	54¾	3	5.5
2,312	Sinclair Consolidated	no	24¾	17	23¾	..	..
1,881	Skelly Oil	25	32½	21¾	32½	2	6
1,750	Mid Continent Petrol.....	no	38	25¾	37	..	..
1,669	Texas Pacific Coal & Oil.....	10	23¾	10½	17¾	..	..
1,524	Simms Petroleum	10	28½	17¾	28	1	3.6
1,345	Barnsdall "A"	25	33½	18¾	33¼	2	6
1,321	Pure Oil (common)	25	33¾	25½	30½	4	13

Ratio of Dividend to Par Value of Stock. Many oil shares were originally purchased at or below par so that, to older stockholders, it may be of interest to learn the percentage which dividends of 1925 made of par value. Naturally, newer investors are concerned with the current market price of shares; so, for the independents, the percent yield on the last quotation in 1925 is shown in first column below. There is not much trading in Standard Oils so that the same information is not given in regard to these.

DIVIDENDS PAID DURING 1925 AND INCOME RATE BASED ON PAR VALUE

% Yield on mkt. price	Independent securities	Par val.	Divi- dends	Div. rate %	Standard securities	Par val.	Divi- dends	Div. rate %
13	Pur Oil (com.).....	\$25	\$4	16	Standard, Neb.....	\$100	\$20	20
8	Pan Am. "A" & "B"...	50	6	12	Vacuum Oil.....	25	5	20
8	Mexican Petrol.....	100	12	12	Standard, Ky.....	25	4	16
5.5	The Texas Co.....	25	3	12	Chesebr. Mfg.....	25	3½	12.5
5.1	General Petrol.....	25	3	12	Cumberland Pipe....	100	12	12
3.6	Simms Petroleum.....	10	1	10	Illinois Pipe.....	100	12	12
4.3	Associated Oil.....	25	2	8	Prairie Pipe.....	100	8	8
6.6	Barnsdall "B".....	25	2	8	Nat'l Transit.....	12½	1½	10
6	Calif. Petroleum.....	25	2	8	Standard, Ind.....	25	2½	10
7.5	Pure Oil (pfd.).....	100	8	8	Standard, Ohio.....	100	10	10
8.7	Sinclair Cons. (pfd.)..	100	8	8	Galena-Signal (pfd.)	100	8	8
6	Skelly Oil.....	25	2	8	Standard, N. Y.....	25	1.4	5.6
4.3	Union Oil, Calif.....	25	1.8	7.2	Standard, Ohio (pfd.)	100	7	7
6	Atlantic R. (pfd.)....	100	7	7	Union Tank (pfd.)...	100	7	7
5.8	Shell Union (pfd.)....	100	6	6	Humble O. & R.....	25	1.2	4.8
5	Tide Water (pfd.)....	100	5	5	Standard, N. J. (com.)	25	1	4

Ratio of Current Assets to Current Liabilities. Based on company reports as of December 31, 1925, the following ratios have been calculated. As annual reports are not yet standardized it is not always easy to segregate the quick assets and current liabilities.* The results are fairly reliable as a guide to those who regard this ratio as a safety factor of great consequence. It is a poor management that will permit current assets to become less than twice the liquid liabilities. The former are made up of crude and refined stocks, cash, accounts and notes receivable, saleable supplies and such other liquid assets as Liberty bonds.

* For this reason the author's results differ radically from those in the table published by Ward, Gruver & Co., 20 Broad St., New York, for the below-named oil companies: Ohio Oil, 13.3 and 25.7; Phillips Petrol., 20 and 4.6; Humble, 5.5 and 1.4; Standard of Ind., 5.2 and 3.6; Standard of Calif., 7.1 and 3.2.

Company	Ratio	Company	Ratio	Company	Ratio
Salt Cr. Producers....	31	Prairie Oil & Gas.....	6.4	Pure Oil.....	4.3
Mountain Producers... 13		General Asphalt.....	6.4	Calif. Petrol.....	4.0
Vacuum Oil.....	11	Shell Union.....	6.3	Simms Petrol.....	3.4
Atlantic Refining.....	9.5	Marland Oil.....	5.5	Sun Oil.....	3.5
South Penn Oil.....	7.8	Continental.....	5.9	Pacific Oil.....	3.0
The Texas Company... 7.1		Standard, N. Y.....	5.3	Pan Am. Western.....	2.8
Union Oil of Calif.... 6.8		Gulf Oil.....	5.2	Sinclair Consol.....	2.8
Mid Continent.....	6.5	Tide Water Assoc.... 4.8		Skelly Oil.....	2.8

Listed Securities. There are several stock markets on which bonds and stocks of oil companies are listed. The two leading ones are the N. Y. Stock Exchange and the N. Y. Curb. An October, 1926, brokers' compilation shows that 110 million shares of common and preferred shares of oil companies listed on the former were worth over \$4,000,000,000. In addition, 18 leading oil issues listed or traded in on the N. Y. Curb Market with 70 million shares outstanding had a market value of nearly \$3,000,000,000.*

RETROSPECT OF RECENT YEARS BEFORE 1926

The Period of Depression, 1922-1924. This succeeded the Readjustment Period, 1919-1921,† which centered on the year of highest prices and prosperity in American oildom. That period averaged 100 million barrels more in yearly yield of crude than the War Period of 1916-1918. Such an increase seemed extraordinary but it was completely eclipsed by the immense 240-million advance of the period 1922-1924. The financial recovery of late 1921 was upset in the summer of 1922 as overproduction gained headway and handed out 85 million barrels more crude than in 1921. This gain was as great as the total output 20 years before. A further favor to the buyers in 1922 was the receipt of 127 million barrels Mexican oil or more than the domestic yield in 1905. Crude stocks climbed 230 percent, from 122 million at the opening of 1919, to 400 million barrels at the end of 1924.

The Depression Period centered on 1923 in which 8 pools attained a daily mark of 100,000 bbls. or more (pages 104 and 143), and production passed both the 600 and the 700 million mark, topping the 1922 total by 175 million bbls. California alone accounted for 70 percent of this great gain. Cheap crude (page 168) began to move from the Pacific to the Atlantic seaboard late in 1922, and still continues (12,666,000 bbls. in 1926 additional to 20,687,000 bbls. refined oil). Such tanker transport cost so much less than piping from the Mid-Continent that the producing industry became demoralized. Whole fields were closed in (as in the Valley of California) and Mid-Continent output was curtailed (pages 72-5, 78-81, and 325-6). The market price fell below the cost of production. The crude business lost \$180,000,000 gross or \$142,000,000 net in 1923. With improvements begun late in 1923 the deficit in this branch decreased to \$115,-600,000 gross or \$24,000,000 net in 1924, according to the Bureau of Internal Revenue. Output in 1924 was 2 percent less than in 1923, *marking the first fall in crude production since 1906*. It was one of the few years in which the last month produced less than the first. The rate of

* Prince and Whitely, New York, N. Y., quoted in *The Wall Street Journal*, October 29, 1926.

† For details about the post-war period 1919-1921, see G. B. Richardson's review in "Mineral Resources of the U. S."; also "The Derrick's Handbook of Petroleum," Derrick Pub. Co., Oil City, Pa. An early review of 1923 appears on page 104.

output was unusually steady, the best week departing from the poorest by only 8.3 percent compared with 32 in 1923, about 23 in 1925, and 27 in 1926. Price cuts occurred, nevertheless. One authority † claimed that the average price of crude oil fell from \$1.49 per barrel in 1923 to \$1.46 in 1924. The oil trade was altogether near a balance in 1924. (For review of 1925 see page 304 and footnote here).‡

REVIEW OF 1926 AND OUTLOOK FOR 1927

Changes in Output of Oil. As a result of drilling 29,310 wells (65 percent proving oil producers) daily production rose steadily during 1926 from 1,900,000 bbls. to 2,400,000 bbls., a 27 percent gain. The total of 775,000,000 bbls. was only 1.2 percent above that of 1925. The new peaks were due to developments in Seminole County, Okla., the Texas Panhandle and Spindle Top. The 25-million advance of Texas was eight times the gain in either Kansas, Louisiana, Montana or Oklahoma. It almost offset the losses in Arkansas (18 mil.), California (6 mil.), and Wyoming (4 mil.). Minor gains were registered in Colorado (1.6 mil. or 140 percent), Pennsylvania (1 mil.), New Mexico, New York, West Virginia, Ohio and Michigan. Flooding in the Appalachian field and gas lift in California and the Mid-Continent contributed a little to the 1926 total.*

Supply Versus Demand. Domestic output added to imports of 60 million gave a new supply of 835 million bbls. plus crude stocks of 418 million on January 1, 1926. Domestic demand approximated 780 million, exports 15.4 million, and stocks on December 31, 400 million bbls. The difference covers the direct consumption as crude outside of refineries and various losses through leakage, evaporation and fire. The demand for gasoline gained 17.2 percent over 1925, but the demand and production of the other major refinery products was about stationary. In the table herewith for the year ended December 31, 1926, the figures stand for million barrels and "New Supply" covers output plus imports.

† *The Lamp*, Feb., 1925. U. S. Geol. Survey figures (page 317) show a betterment, from \$1.34 to \$1.43 at the well. Not a single new pool attained a peak of 100,000 bbls or more daily during 1924. Long Beach led again, but Salt Creek declined 70,000 to 50,000 daily at the end of 1924.

‡ *Prosperity Revived in 1925.* New peaks were reached in daily and total output, respectively, 2,347,000 bbls. (average, week of May 30) and 764,000,000 bbls. The Wortham pool (p. 165) attained 167,000 bbls. daily about the middle of January; Smackover, 431,000 bbls. late in May; Inglewood, 113,000 Aug. 1; Garber (p. 142), 73,000 Nov. 22. Imports declined 20 percent to 62,000,000 bbls., hardly half of the 1922 receipts. Crude exports of 13,400,000 bbls. were less than in 1924 and not quite as large as Atlantic seaboard receipts of California crude. Refinery runs climbed over 20 percent. Stocks grew to 418,000,000 bbls. crude and 120,000,000 bbls. refined. Despite the deluge at Smackover, prices rose early in 1925 and stayed fairly firm in the Mid-Continent until reduced on Aug. 27. The average approximated \$1.68, or 25 cents a bbl. more than in 1924 (U. S. G. S.). On that basis the 1925 output at wells was worth fully \$1,280,000,000, a value exceeded only in 1920 and 1926. Gasoline prices were higher than in 1924. Exports of all mineral oils totaled \$473,000,000, or almost \$70,000,000 more than the average for the five years 1921-1925. Earnings so improved that some producers paid dividends again and oil securities were in greater demand. The period of 1925-1926 was noted for a series of sensible mergers consummated in behalf of practical conservation.

* *Pools of Fourteen Million or More.* Both Hutchinson County (Tex. Pan.) and Seminole passed Smackover in daily rate before the end of 1926. But Smackover, with 52 mil. bbls. for the year, retained its leadership on the larger basis. Long Beach was second (38 mil.) and Midway-Sunset third (34 mil.). Others in order were Hutchinson Co. (23 mil.), Huntington Beach (19), Santa Fe Springs (17.4), Inglewood (17.4), Burbank (16.4), Spindle Top (14.8), Ventura Ave. (14.8), and Tonkawa (13.9) (See *Oil & Gas Jnl.*, Feb. 10, 1927, p. 96). The deep sands at Spindle Top produced alone in the second half of 1926 more than the year's increase for the entire country. One tract of 1½ acres there had yielded over 2,100,000 bbls. per acre up to April, 1927, the highest for the United States.

Products	Dom. demand	Exports	Total demand	New supply	Stocks, 12-31
Gas and fuel oil.....	340	38.4	374	379.6	25
Gasoline †.....	262.2	43.5	205.7	305.8	39
Kerosene.....	38.3	21.6	59.6	61.8	8.6
Lubricants.....	22.6	9.4	32.0	32.3	7.6

Strategy of Storage. According to W. C. Teagle, oil stocks are now excessive not only because of the capital (over \$1,200,000,000, pages 303 and 323), tied up but also because each barrel of crude is the equivalent of almost 2 barrels in ante-cracking days when none of the gas and fuel fractions were converted into gasoline. "Under such conditions neither advance nor maintenance of posted prices for crude is justified in the interest of the industry or even the producer." Storage of huge supplies (p. 81) would otherwise serve as a much stronger factor in the stabilization of prices for finished products.‡

Steadiness of Prices. Prices did not vary so much as in the three preceding years. Steady increase in consumption, slightly reducing total stocks to about 500 million barrels, permitted prices to be well maintained, even strengthened up to November for some of the lighter crudes. Fair prices for gasoline and other products, shaded a little late in 1926, averaged 1 cent higher than in 1925 when the average tank-wagon price in 50 cities was 17½ cents. This allowed prosperity to prevail throughout the industry during 1926. One result was the wiping out of deficits for many small producers. Others procured earnings for dividends and surplus even better than in 1925, as indicated in the table below.*

Cities Service oil subsidiaries, chiefly Empire Gas & Fuel Co., earned around \$7,500,000 net in 1925 and \$9,000,000 in 1926.

A uniform gain of only 12 percent for the 65 oil companies which in 1925 earned \$650,000,000 net would make their total \$728,000,000 in 1926.

NET PROFITS OF OIL AND OTHER LEADING OPERATORS, IN MILLION DOLLARS
1925-1926

Independents	1925	1926	Standards	1925	1926	Miscellaneous	1925	1926
The Texas Co....	39.6	36.0	Standard, N. J....	111.2	117.7	Gen. Motors....	116.0	186.0
Gulf Oil Corp....	35.0	35.1	do., Calif.	43.6	55.1	U. S. Stl. Corp.	118.0	143.0
Shell-Union	20.4	31.5	do., Ind.	55.9	55.1	Am. Tel. & Tel.	107.0	117.0
Phillips Petrol... 12.3	21.4	do., N. Y.	41.6	32.8	Pennsy. Ry....	62.0	67.6	
Sinclair Consol... 6.0	17.0	Pan Am. P. & T.	27.3	31.3	N. Y. Cent. Ry.	48.0	55.7	
Pure Oil.....	12.9	16.0	acVuum Oil....	24.2	25.0	Dupont	24.0	41.9
Tide Water Assn. 16.5	13.4	Humble O. & R..	22.6	19.4	B. & O. Ry....	21.0	28.5	
Union Oil.....	10.5	11.8	Prairie O. & G..	14.2	16.0	Am. Smelt. & R.	15.2	17.8
Marland Oil..... 14.8	11.7	Ohio Oil.....	9.4	13.5	Chrysler Corp..	17.1	15.4	
Mid-Continent... 7.0	8.6	Standard, Ky....	7.2	7.3	St. Joseph Lead.	8.2	9.4	
Calif. Petroleum. 6.3	6.6	Atlantic Rfg....	7.2	7.2	Unit. Gas Impr.	8.1	9.3	
Amerada Corp... 2.5	5.0	Standard, Neb..	7.2	5.9	Baldwin Loco... 0.2	5.9		

† The output of gasoline gained 40 mil. bbls. (p. 304), or 15.5 percent. Its recovery from crude increased from 35.1 percent to 38.5 percent (16.1 gals. from 1 bbl.) in 1926. Nearly 94 mil. bbls. came from cracking. Stocks of this motor fuel on Mar. 31, 1926—46.1 mil. bbls. (of 42 gals.)—were the highest in history until 12 months later when 52.4 mil. bbls.

‡ See *Wall St. Jnl.*, Mar. 15, 1927, and *Oil & Gas Jnl.*, Mar. 17, p. 29. On stabilization Pogue noted three ways in which the industry progressed in 1926: (1) Better control of crude production (except during the last quarter); (2) increasing encroachment of gasoline demand upon the fuel oil supply for cracking; (3) lowering cost and indirectly swelling profits through advance in technical efficiency in both field and refinery.—*Oil Trade*, Feb., 1927.

* The petroleum business (in the fall of 1926) was in better shape than it had been for five years. When the large buying companies are forced to build storage for crude from flush fields, the producer must realize that the cost thereof is taken from the price paid.

* * * It is production in flush fields that wields the greatest influence on the crude price structure.—*Oil & Gas Jnl.* See also *Wall St. Jnl.*, Nov. 9, 1926. Commenting on the gasoline situation, the Harvard Committee on Economic Research was quoted in the *Phila. News Bureau* Nov. 29: The N. Y. tank-wagon price remained unchanged since June at 21 cents. This is contrary to the experience of the four years preceding, in each of which gasoline prices declined in the spring and summer (p. 113). The failure to drop was ascribed to two facts: (1) Mid-Continent crude prices remained firm until recently, and (2) gasoline stocks were low again. (The table above was compiled by John D. Wright.)

U. S. Petroleum Trade. Crude imports declined slightly to 60.4 million bbls. worth \$80,000,000 in 1926. Exports in millions were as follows: Crude, 15.4; gasoline, 43.4; gas and fuel oil, 38.4; kerosene, 22.1; lubricants, 9.4; also 167,000 tons of wax. The value of all mineral oils exported exceeded \$550,000,000, a new record, two-thirds of the value of the raw cotton exported.†

Domestic Doings, 1926. The first year of the Twentieth Century's second quarter proved eventful: (1) The nation hit new highs in production and so did 5 states west of the Mississippi (Texas, Oklahoma, Montana, Colorado and New Mexico); (2) Spindle Top proved the most spectacular pool, its comeback being staged after the mid-year and its sudden production per acre being unequaled; (3) the Texas Panhandle passed the 165,000-bbl. mark from less than 25,000 bbls. daily in May; (4) the Seminole field contributed heavily during the second half of 1926; (5) the Bradford-Allegany field (Pa.-N.Y.), brought its output up to 6.2 million bbls. for the year, remained first east of the Mississippi and became 31st in the United States after experimenting with soda solution in its water drive (pages 72 and 145); (6) an unusual run of tank-farm fires occurred in California during April with loss of \$12,000,000 besides tanker explosions elsewhere involving loss of life; (7) a storage record for gasoline of 46.1 million bbls. reached on March 31; (8) new peaks in production, domestic demand and exportation of gasoline; (9) largest financial rearrangement in American Oildom through retirement of \$230,000,000 worth of 7 percent preferred stock in Standard Oil of N. J. in favor of its first bond issue (\$120,000,000 5 percent) and additional common (3,449,317 shares of \$25); (10) organizing the new Texas Corp. of Del., with \$250,000,000 capital; (11) Vacuum Oil, oldest active operator, celebrated 60th anniversary; (12) second bond issue, Standard of N. Y., \$50,000,000 (25-yr. 4½ percent debentures); (13) largest fuel oil contract for 14 million bbls. Sunburst oil, by Great Northern Ry.; (14) cash dividends of over \$200,000,000 by the old Standard Oil group; (15) growth in furnace oil demand despite 31 percent rise in refinery prices; (16) Federal Oil Board's first report, September; (17) \$500,000 fund for research under supervision of the A. P. I. aided by the National Research Council.*

Noteworthy World Events. Major happenings in the Eastern Hemisphere included (1) Rumania's rise of 40 percent in output of crude; (2) the beginning of natural gasoline recovery in Russia; (3) the coal strike stimulant to demand for oil in England; (4) the Soviet's efforts to sell oil from nationalized wells of foreign owners; (5) preparation of the Batavian Petroleum Co. (Royal Dutch-Shell‡ subsidiary controlling East

† *British Petroleum Trade in 1926.* Crude imports increased from 3 mil. bbls. in 1921 to 16.3 mil. in 1925 and fell to about 15 mil. in 1926. Gasoline receipts grew to the new peak of nearly 16 mil. bbls., gas and fuel oil to 14.7 mil., and kerosene to 5.7 million. The reduced crude receipts reflected the industrial depression in the Kingdom. Gasoline consumption expanded to about 650 mil. Imperial or 780 mil. American gallons in harmony with the increase in motor vehicles. Hardly one-fifth of this came from British refineries. The United States, as usual, supplied more than half of the mineral oils other than crude. Persia was the principal source of the latter, 77 percent in 1926, 67 percent in 1925, according to U. S. Trade Commissioner H. S. Fox, London, in *Commerce Reports*, Mar. 7, '27.

* For other events of 1926 consult annual review numbers of periodicals, such as *The Oil & Gas Jnl.* (Feb. 10 issue of which contains 3 pages of necrologies), *Oil Trade of March*, and *Oil Weekly*. On "Mexican Petroleum Industry in 1926," by Vice Consul S. G. Beck, see *Commerce Reports*, Apr. 18, 1927.

‡ Combined capital of Royal Dutch and "Shell" Transport & Trading Co., Ltd., was in 1925 about \$255,000,000; net income, \$60,422,802, of which \$24,441,600 came as dividends from the Batavian Petroleum Co. See also Shell-Union, index and preceding page.

India's production) to increase capitalization to nearly \$175,000,000 by the issuance of 25-yr. 4½ percent debentures on January 1, 1927. In the Western Hemisphere (6) Colombian crude began moving to Bayonne, N. J., after completion of Andian pipe line (pp. 217-218, 360); (7) Venezuela developed a monthly output of over 3 million bbls. and displaced Persia in 4th rank; (8) Secretary Kellogg denied the right of the Calle's regime to take land titles away from American oil operators in Mexico; (9) a Washington jury acquitted E. L. Doheny of wrongdoing after testimony that the Navy had asked him to build storage in Hawaii; (10) the world's deepest test for oil, near Fullerton, Calif., reached 8,046 feet in September (p. 310); (11) the world's largest single refinery, the Gulf Refining Co.'s, at Port Arthur, Tex. (p. 137), increased capacity to 125,000 bbls., and (12) hydrogenation under high pressure can convert 50 to 60 percent of coal into oil according to Dr. F. Bergius before an international congress held at Pittsburgh (see editorial, *N. Y. Times*, March 20, 1927).

Outlook for Oil in 1927. The new peak of practically 2,500,000 bbls. daily (almost one-third of British India's yearly yield) reached for the last week of February proved how futile forecasts are in the oil industry. However, indications are for continued high output well into the summer in view of Seminole's persistence and the resumption of activities in West Texas and elsewhere with the coming of spring. The outlook is therefore not so good in the first half of 1927. The several price cuts in crude and refined oils, begun last November, will result in reduced earnings. Because of the cost of storing oil above ground recourse must be had to bank borrowing or public financing (*Barron's*, March 21.) A. S. Farish no doubt referred to restrictions in wildcatting and curtailment in production through cooperative agreements encouraged already by the Federal Oil Board when he declared that upon the producers themselves, in great measure, depends the welfare of the petroleum industry during 1927 (*Wall St. Jnl.*, February 17.) However, conditions during the first quarter of 1927 appear to favor the transportation department of the industry, particularly pipe-line and tank-car companies in which the public owns shares (*Wall St. Jnl.*, April 13, 1927).*

* Chairman Jones, of the N. J. Standard, estimated the 1927 output of crude in the U. S. at 800 million barrels. Pres. Reeser, of Barnsdall Corp., was quoted by *Barron's*, Jan. 27, in an optimistic way: Demand for all petroleum products in 1927 will exceed last year's requirements by 8 percent. There will be a 14.5 percent increase in gasoline consumption to a total of 14,300,000,000 gals. (340,000,000 bbls.) in 1927, according to the *Oil & Gas Jnl.*, Dec. 30, 1926. R. J. Pilcher, before the Los Angeles section of the A. I. M. E. last December, denoted the California situation as unfavorable with over 50,000 bbls. of shut-in production at that time and with an expected daily rate of 632,000 bbls. in July, 1927. Unsettled conditions in the oil business may be expected to continue until the appearance of a leader like E. H. Gary in the steel industry, according to D. L. Moffett, vice president, Mid-Continent Petroleum Co. Henry G. Lapham, a director in The Texas Co. (p. 343), looks for chemistry to play an increasingly important part in the oil industry. Sir Henry W. A. Deterding considered the industry to be in a very healthy condition last year, but "expansion, however, depends on credit. To develop the industry properly will require hundreds of millions. * * * The production of synthetic benzine (gasoline) would be possible only if protected by high tariff. Most optimistic estimates are for only 50,000 tons (say 350,000 bbls.) a month by 1928."—*Wall St. Jnl.*

The latest peak, of 2,505,000 bbls. daily, was attained in May, 1927, when Seminole culminated at 360,000 bbls. daily. The year's yield may exceed 840,000,000 bbls. unless drilling is curtailed. Leading operators, alarmed at the super-flood—simultaneous with the overflowing of "The Father of Waters"—gathered in New York, May 11, and actually appealed to the Government for the protection of the industry against itself.

CHAPTER XIV—PREVENTION OF FRAUDS AND FAILURES *

"Are Americans people? Believe me, yes—the most criminally careless people in the world, the most easily gulled."—From Emerson Hough's "Last Message to the American People."

INTRODUCTORY

Extensive Evil Arousing Public Wrath. The World War wrought damages in diverse ways. Much harm has come from the speculative spirit which during and since the war has spread to persons of all ages and conditions. It has been experienced even in our educational institutions. Lowered standards of honesty towards oneself as well as others have accompanied this uneconomic epidemic. In the United States leading thinkers have realized this, and the result is the advocacy of special instructions in thrift, truthfulness, and honesty in our schools† and the establishment of agencies to discourage dishonesty, theft, and frauds.

Noteworthy Work of the National Better Business Bureau. Among the latter may be mentioned the National Vigilance Committee of the Associated Advertising Clubs of the World and its affiliated Better Business Bureaus in nearly 50 principal cities throughout the country. These agencies are striving for truth and honor in advertising of all sorts and have established investment departments in their organizations to assist the inexperienced investor to obtain *all* the facts regarding a company whose securities are offered. In the operations of these investment departments a great number of frauds have been exposed and many thousands of dollars saved for the investors by giving them an intelligent understanding of the worthlessness of so-called securities they have inquired about.‡

Education of the Gullibles the Great Safeguard. "An ounce of prevention is better than a pound of cure." The opportunity exists for an organization to coordinate all efforts to educate the public, particularly the coming generation of business men and investors, so that disastrous speculation and fraudulent promotions may be minimized as much as possible. If hanging speculators who inveigle millions of dollars of hard-earned savings from the pockets and hiding places of poor people would restore these people their money, then the argument for hanging would be overwhelming. But when the money is gone any public concern is useless except the consideration of how such wholesale slaughter of human contentment may be prevented in the future. Encouraging report comes from New York that high-school students, as shown in an examination, are beginning to know a little less about baseball statistics and movies and a little more about De Valera, Lloyd George, Briand, and General Wood. But what high-school pupil, to

*There would be no occasion to write this chapter were it not for the two traits of greed and ignorance. Very few of us do not have these in some degree. Swindling practices would prove impossible if human beings were neither ignorant nor greedy, and if the knowledge thereof were not possessed by the fraudulent promoters. Mr. Ford evidently had education in mind when he contributed his page to the *Dearborn Independent*, of December 12, 1925:

"Whether to be sorry for the victims of swindlers, or glad that they are getting experience; whether to desire a spineless population never tempted to (commit) folly, or a strong people who are proof against it; these questions occasionally arise. * * * If rust-proof wheat is a possibility, surely folly-proof people are equally possible. The swindlers who take millions a year from the people would fail if people were swindle-proof; and most of them would be if they refused to heed tales of something for nothing."

†According to the *Baltimore Sun*, the Blue Sky Committee of that city has been cooperating with the Public School Association in extending anti-fraud education.

‡Read "Protection of Good Will of the Oil Industry" by Lou E. Holland in *The Oil Weekly*, December 29, 1923. The National Vigilance Committee has been incorporated as the National Better Business Bureau.

say nothing of the thousands who never reach high school, knows the first principles of investment and how to protect his savings from men like Ponzi and Chicago's new wizard of high finance? There appears to be no limit to the gullibility of simple folk before whose eyes is dangled a vision of riches. A grounding in the first principles of safety in investment might save them later on from discouraged and broken lives. The public doesn't love to be cheated. The appearance that it does is but a monument to its pathetic ignorance of financial security and responsibility.*

WHY ROGUES AND IGNORAMUSES PREY ON PETROLEUM

The Oil Business a Fertile Field for Imposition. There are crooks in every business, but if any business is new or novel or notably prosperous, and particularly romantic, then it will naturally attract not only the crooked promoter but also the ignorant interloper. It is not always easy to distinguish between these two agents—the one of fraud and the other of honest failure—for the ignoramus may be tempted to try the twilight methods of the fake promoter, especially when competing for the capital of small investors. Petroleum happens to have been peculiarly attractive to investors during the past decade. Development of the great Cushing field in Oklahoma and that of the Midway-Sunset in California were highly sensational, yet they did not give the grafters the opportunity that came with the try outs in Texas and the wildcatting in Wyoming.

Magnetic Points About the Mineral Oil Industry. Here are some of the attractions which, for the past dozen years in particular, have made a lodestone of petroleum for investors and speculators:

- (1) The new developments were first carried on far enough away from the populous centers to make "distance lend enchantment to the view";
- (2) these were later in part located near enough to the largest city on the Pacific coast to permit wholesale personal inspection of genuine gushers by tourists and other credulous investors;
- (3) the oil business more than ever before has proven romantic through its spontaneous and spectacular development;
- (4) vast fortunes have been quickly but honestly acquired by a few American operators in bonanza fields and the stories thereof have been given wide circulation;
- (5) through no other industry have suddenly so many American land owners of limited means been raised to positions of financial independence;†
- (6) two of the world's largest corporations are oil companies with either physical assets or securities exceeding 1,000 million dollars each;
- (7) as a whole the industry, excepting the crude production branch, has been persistently prosperous, especially in regard to the "vertical" monopolists;
- (8) bona fide instances have been known of small companies declaring earned dividends ranging from 100 to 1,000 percent in the course of one or two years;
- (9) there are, as a rule, more ways to interest small investors in oil than in other branches of mining and manufacturing;
- (10) the gigantic growth of this industry, excelled only by the automotive business (in production of crude oil exceeding 200 percent in 11 years) has called for an enormous increase of capital for drilling, piping, tanking, and refining. These 10 reasons may be resolved into six groups: (a) Peculiarities of the natural resources; (b) speedy and spectacular develop-

*Editorial from the *St. Louis Post-Dispatch*, February, 1922.

†Others as mere leaseholders and royalty owners have also made money without running the risks of the operators or lessees.

ment; (c) continuous need for new capital; (d) examples of success; (e) diversified ways of making money; (f) great geographic range of the industry and its innumerable customers.

A TEN-YEAR TALE OF TRAGEDIES

Rocky Mountain Wreckage. In early years the promotion of fake oil companies was done secretly and rarely were the newspapers used as aids in these promotion schemes. Not until 1914 and 1915, when the demands for oil became great and producing wells were drilled in wildcat territory in the Far West and Northwest, did these promoters start their work. Wyoming was used as fertile soil for these companies, and in two years \$300,000,000 was obtained from the public by oil companies claiming to have valuable leases in the State of Wyoming. Denver was the headquarters for most of these companies. Literature was broadcast throughout the United States and glaring advertisements were inserted in daily and weekly papers and magazines. Of the \$300,000,000 given these corporations, less than \$10,000,000 was actually spent in the development of oil property. In contrast, it may be stated that the annual production of oil in Wyoming was less than 10,000,000 barrels before 1918; and of this amount a majority was owned and controlled by two large companies. These and other companies operating in the Big Muddy, Greybull, and Pilot Butte fields and not advertising stock for sale, produced and marketed 95 percent of the oil produced in Wyoming. It is safe to say that of the 200 or more companies organized in Wyoming in 1913, 1914, and 1915, less than 25 ever drilled a well and less than five produced oil. Of the \$300,000,000 invested, practically every dollar was lost; and of the corporations which advertised extensively in these years only one was known to produce oil in paying quantities.

Texas Tragedies Partly Told. The scene shifted to Texas following the big discoveries in the Ranger field in Eastland County and Burkburnett field in Wichita County. The promotion companies began activities in 1917 and soon became very active in this state. Approximately 1,000 oil companies were incorporated within two years to do business in Texas, and eventually between 90 and 95 percent of them proved fraudulent, so that the "invested" money was lost. While Texas is the third largest producer and there are still valuable virgin deposits of crude petroleum in that state, probably 99 percent of the production and the proven territory is controlled by the legitimate oil companies *who do not advertise their stock for sale*. An experienced oil investigator connected with the Government estimated that 91 pct. of these 1,000 companies were organized for the sole purpose of selling stock. He figured that 60 percent of the money invested by the clients of these companies was for promotion purposes, 20 percent for advertising, and 10 percent for overhead expenses; but *less than 10 percent was actually spent for leases and for the drilling of oil wells*. This investigation showed further that from 92 to 94 percent of the wells drilled in purely wildcat fields were failures, largely for lack of geological advice. Stockholders, by a common-sense method of reasoning, can figure out what chances they have to win by investing in these promotion companies.

Nomadic Scoundrels Do Not Always Escape. The crowded scene in the Burkburnett field was only one part of the picture. With its development,

together with that of Ranger, Fort Worth became the capital of a vast oil-promotion movement. In this bustling burg was mobilized almost overnight the largest group of persuasive stock artists that this country has ever known. They created a selling literature that Wallingford might have claimed with pride. One group, together with others of the same ilk, both at Fort Worth and Houston, were convicted of fraudulently using the mails and were sent to prison early in 1924. Like Ranger and Burburnett, Smackover temporarily (in 1923) became a paradise for unscrupulous promoters. The development of this field in southern Arkansas came at a psychological moment, for it followed upon their activities in northern Texas.*

Legitimate Dealers in Lands, Leases, and Securities. It must not be inferred that all transactions in oil lands or oil shares are fraudulent. There are many decent dealers in lands and leases located in the various oil fields and nearby towns. There are dozens of large legitimate brokerage houses in big cities which are advertising oil stocks for sale, but in practically every case these houses, before putting the stock on the market, make an investigation into the properties and their advertisements, while in most instances optimistic, are not misleading. There are also investment bankers who deal in securities, but only for themselves and their friends, as a rule. Rarely do they deal in speculative stocks, but they will buy and sell bonds of the best oil companies.

Honest But Ignorant Promoters. We have another group of promoters that have brought fully as much, if not more, sadness and bitter experience to investors than the crooks, and that is the ignoramuses or would-be oil men. Honesty alone is not the only essential in the management of an oil enterprise, or of any type of enterprise. Poor management is probably responsible for fully 60 percent of all business failures. In addition to honesty, the management must be capable and efficient. Have you ever met a great many inventors? How many of them show any business ability in addition to their inventive genius. We know of only two who are prominent today—Henry Ford and Thomas A. Edison. Yet thousands of inventors are almost as clever in other lines, but have not the business ability to put their ideas before the public eye. The same is true of promoters—once in one thousand you will find a man who combines a business head with promotional ability. It takes a real business man to make a real oil man.

The Unscrupulous Promoter. There is in every community a class of men who make their living by their wit, cunning, and shrewdness. These are the men who readily enter the promotion game. Some have scruples and enter it with the best of intentions, and they conduct their operations in an honest and business-like way. Many, however, are unscrupulous and have no regard for honesty and square dealing. This is the promoter of

* The man most active in the prosecution of these parasitic promoters was Edward A. Schwab, of the National Vigilance Committee.—I. F. Marcossion, *Saturday Evening Post*, April 19, 1924, page 205. This periodical ran a series of wordy but wise articles on oil beginning late in 1923. The application of shrewd real estate methods were vividly set forth in the article on California. "Once the gold mine held out the irresistible bait for the people's savings." Hence Mark Twain's maxim, "A mine is a hole in the ground in which a fool drops his cash." Today, despite the fate of the Dr. Cooks and the loss of more than \$1,000,000,000 in the last 10 years in fraudulent oil stocks—it is difficult to arrive at the exact losses because the suckers seldom squeal—John Jones pursues this phantom of the golden gusher that will make him rich overnight.—I. F. Marcossion in the *Saturday Evening Post*, May 24, 1924.

whom the investor, especially the small investor, should beware. He is the "wolf in sheep's clothing," whose sole object is to separate you from your hard-earned savings. He approaches the unwary investor with pleasing bait, promising great dividends, and giving out garbled statistics. He tells you the story of the man who had the opportunity to invest with Bell, but didn't; the story of the man to whom Henry Ford offered an opportunity to risk a couple of thousand dollars, and a few more such tales, followed by a list of about a dozen oil companies in which a hundred dollars would have made thousands. But does he truly offer you an equal opportunity? Certainly not! Sometimes he tells you a pretty story about the liquid gold that underlies a lease which he has just been able to purchase. He sends you a statement of some unheard-of geologist to prove his claims, or he selects a high-sounding name, typical of his ambitions, and tells you how morally responsible he really is, how philanthropic, how much he desires to do all the good that is possible in this world, and how dearly he would love to make you rich! But does he give you any method of verifying his statements? Certainly not! Perhaps he gives you the names of a few local friends—never anyone but his friends!

Promotion Stock and Capitalization. An important item entering into the causes for losses in oil companies is the so-called "promotion stock." When a promoter organizes an oil company he puts into that company certain assets, such as oil lands or leases, equipment, labor, or any one of a hundred other things which are of value to the company. For this he receives stock in the company. If he is honest, he takes only an amount in accordance with the real value of the assets, but if not, he places an inflated price on his labor, or properties, with the result that stock purchased by the investors is saddled with the heavy burden of making good on all the outstanding shares before the stock purchased by the investor can receive a dividend or profit. And in most of these companies the promotion stock amounts to 51 percent of the entire capitalization.

TRACING THE CAUSES OF TRAGEDIES

General Facts About Nonfraudulent Affairs. A few years ago a well-known efficiency engineer estimated that industrial efficiency in this country is not more than 40 percent, in some cases as low as 15 percent of what it should be, and on the average about 25 percent of attainable standards. The average efficiency of the worker was then 60 percent, that of the machine 70 percent, that of the plant 70 percent, and that of material 86 percent. *Bradstreet's Summaries* one year gave the following reasons for failures: Incompetence, 38.2; fraud, 7.0; speculation, 7.0; inexperience, 5.6; neglect, 1.7; extravagance, 1.1; lack of capital, 30.3; failure of others, 1.7; unwise credits, 1.3; competition, 1.1; specific conditions, 11.3; total, 60.6.

Faulty Management. From the above it appears that the management was directly at fault to the total extent of over 60 percent; but if we charge thereto lack of capital, then there falls within the control of management almost 91 percent! But in the particular case of oildom failures, the man-

**Sample of a Seductive Song.*—"This is not a wildcat proposition. Ask any oil operator who is familiar with our holdings what they think of our proposition. Back your own judgment, use your own head, it might be better than the other fellow's, after all. It is *your* investment that makes money for you. The person who is afraid to take a chance never gets very far. Read the record of all money-makers, and you will see that they all took a chance."

agement is not so badly to blame, because the natural hazards are so high in the exploration and development stages. Before considering the special causes for failures in the oil and gas business let us look a little into the elements of incompetence: First it is found that neither the so-called investors nor the stock promoters monopolize all the ignorance current concerning the legitimate oil industry; the incompetent operator-manager of the ordinary small petroleum enterprise—all the way from wildcatting to refining and marketing, evidently commits many an error owing to ignorance alone.* Probably three fourths of the incompetence or fully one-fourth of all the failures is based upon deficient knowledge, not only of facts pertaining to petroleum in particular but also of fundamental principles of good business practice in general. Ignorance can be remedied, but certain other qualities in men of maturity can hardly be cured. One of these is inherited inability to make complete mental analysis of difficult situations that may arise; haste in arriving at conclusions is another; failure to cooperate or consult others, often based upon false pride, is a third; a fourth reason for the managerial incompetence is found in deficient psychology in regard to subordinates. The last is highly important with the oil industry because of the personal equation in its relation to the many hazards associated with the drilling of wells and the finding of oil.

A RAFT OF REASONS FOR OILDOM WRECKS

Grouping the Related Reasons. A canvas of oildom's failures would reveal valuable information; but in the absence of statistical data it is difficult to arrange the causes in the correct order of their magnitude. They may, however, be grouped under the following heads: (a) Capital or fiscal, (b) natural resources, (c) human labor and managerial, (d) physical and mechanical, (e) scientific or technologic, (f) economic or business, (g) legal. With unlimited capital, most of the other difficulties may be removed provided that common business sense controls the management.

Why Would-Be Producers and Small Producers Commonly Fail. In the approximate chronological order in which they may occur, they are listed herewith 45 causes for the collapse of small oil companies or for their failure to make money for their stockholders.

1. Wrong type of organization—simplest and least costly, a syndicate of fewer than 25 members.
2. Insufficient working capital—often due to extravagance in raising it.
3. Overcapitalization considering present net value of the oil property owned or leased.
4. Defective title to freehold or leasehold.
5. Wildcatting away from port, railway, or market.
6. Testing worthless territory on advice of pseudo-geologist.
7. Neglecting to employ scientific or technical talent for whatever purpose needed (pages 40 and 43).
8. No surface signs of oil deposits (p. 26).
9. Omitting structure tests before drilling deep wildcat.
10. Locating initial test off structure.
11. High dry-hole hazard of spotted district.
12. Abandonment or excessive cost because of greater depth to sand than anticipated.
13. Improper system of drilling—as rotary instead of standard or cable tools instead of core drill.
14. Loss of hole through defective or incomplete equipment.
15. Drillers dishonest or inexperienced.
16. Logs misleading or incorrect.

*See foot-note, page 40, and "Economic Guidance," page 68; also Chapter XI, under "Losses."

† Chapter 2. ‡ Chapter V, particularly page 68.

17. Unusual water or quicksand troubles. 18. Spacing too close. 19. Belated offset drilling. 20. Rigorous requirements as to time and number of tests. 21. Developing during high-cost or boom period. 22. Exorbitant bonus for lease (pp. 314 and 318). 23. Royalty disproportionate to cost of drilling and producing or to income from working interest. 24. Cost of wells not paid out during flowing stage. 25. Inadequate or no marketing facilities when production is obtained during period of good prices. 26. Waste of oil or gas in various ways. 27. Short life of wells or leasehold. 28. Low percentage of ultimate recovery (p. 43). 29. Settled production rate overestimated or economic limit too high for profitable operation. 30. Distance too great between home office and operating center.

31. Storage lacking during period of depression. 32. High overhead expense as for salaries or office rent. 33. Living or other conditions unsatisfactory to employees. 34. Inferior quality of oil. 35. Low prices for products. 36. Building pipe line without justification. 37. Activities limited only to the drilling and operating of wells. 38. Reserves not proven or acquired for future operations. 39. Incorrect cost accounting. 40. Paying rentals without a recommendation of a real geologist. 41. Paying dividends unwarranted. 42. Merging at wrong time or with undesirable concern. 43. Buying or selling producing leaseholds without appraisal by a disinterested valuation engineer. 44. Opportunities of merit overlooked or declined without investigation. 45. Lack of perseverance in the face of discouragement.*

Why So Many Independent Refiners Fail. Some of the reasons why small producers fail apply with equal force to failures in refining, such as (2), (5), (30), and (34), stated above. Some refineries have been built in isolated fields of uncertain ultimate production and others were fitted for refining a certain grade of oil the supply of which became quickly exhausted. Most small and independent refineries are incomplete; they miss the profits to be made on by-products. H. G. James† recently declared that the weakness of the small independents, all too often, has been that they failed either in vision, or natural ability, or in command of capital. In times of prosperity they overbuilt; they failed to create a surplus to carry them over the ever-recurring periods of recession which have characterized the oil business. To some extent they have been victims of the highly speculative character of oil and its rapid fluctuations. It has been claimed again and again that the dominant factor in the industry has crushed the weaker, and however we may look at it, it has always been, and will probably continue always to be, a question of the survival of the fittest.

THE PREVENTION OF FAILURES

Finding the Actual Facts. As many as possible of the following facts should be ascertained before investing in any oil or mining venture. If

*A notable example of success through patience and persistence is that of the Union Oil Co. of Calif. in finding one of the six greatest fields ever discovered within the United States. The first well in the Santa Fe Springs field was completed in 1919, although the big discovery did not come before 1921. The first production of oil came from a depth of 4,595 feet after three wells had been drilled through a period of 10 years. It took a little more than two years to drill the third well. For this operator's successful rejuvenation of its Santa Fe wells through gas lift see *The Petroleum World*, Dec., 1926.

† From speech before the Dallas meeting of the Western Petroleum Refiners Association printed in *Petroleum Age*, April 1, 1924. Mr. James, who died suddenly late in the summer of 1926, was one of the founders of the Am. Pet. Inst.

particular at all about the source of your information, and your banker is too busy, or your lawyer has left for some legislative hall, and no better investment adviser is available, don't hesitate to call on a reputable geologist or engineer familiar with natural resources.

First. The charter should be examined by a competent legal authority, to see that the preliminary work of organization has been properly carried out, so that all shareholders are assured of their rights and adequate protection.

Second. Expert accountants should verify the books and records of the company, and well-versed oil men should make an appraisal of the holdings to arrive at the true value of the assets behind the amount of capitalization.

Third. The cost of transporting the rigs and materials to their locations, also the cost of fuel, water, etc., should be estimated, to determine the probable cost of drilling a well in the contemplated localities, allowing a reasonable amount for contingencies.

Fourth. The manner in which the wells in the vicinity of their holdings hold up should be investigated, to determine if a well drilled would show a sufficient profit to pay for the money spent in drilling it.

Fifth. How much of the oil well is the investor buying with his cash? Unless he can determine this with approximate accuracy, he would do well to seek for some other form of investment.

If it is a lease which is being offered for sale, the investigation should include:

First. The location with respect to present operations, and the type of wells found in that vicinity (the larger the wells, the greater their value).

Second. The length of time for which the lease is made out, to determine that it is for a sufficiently long term to allow developments to get nearer if far away at present.

Third. The rental to be paid to the property owner. (Some rentals are exorbitant and lessen the value of the lease, especially if it is expected to be held for some length of time.)

Fourth. The status of the title should always be carefully gone into by competent legal authority.

Fifth. The recording of the assignment or lease in your own name should be promptly taken care of.

Distinction Between Gross and Net Present Worth. An oil lease may contain 1,000,000 barrels of oil when oil is selling at \$2 per barrel. This does not imply that the lease is worth \$2,000,000. First, there is to be deducted from this the payment for royalty, usually one-eighth of the oil; then there is the cost of development and equipment charges spread over the life of the property, following which are expenses for pumping, transportation, and other operations. These may amount to \$250,000 for royalty and \$750,000 for developing and operating. Since the remaining \$1,000,000 is not obtainable at once, but is returned gradually throughout a period of several years, it will be necessary to discount this sum to get at the present worth of the enterprise.

Double Discount—For Time and Risk. For an ordinary oil venture, a discount factor of 10 percent is not too high. This would further reduce the \$1,000,000 to about one-half to three-fourths thereof, depending upon the estimated life of the property. The result would approximate the

value of the property, without allowing anything for profit in excess of the 10 percent interest. Since this industry is so hazardous, the interest rate is not a safe margin for profit on investment. The \$500,000 should be further discounted by the amount that one would expect to get on the return of his money as a profit. This should not be less than 15 or 20 percent, so that the net value that a prospective purchaser should pay for an oil lease or property, with 1,000,000 barrels of \$2 oil, would not be in excess of \$400,000, or about one-fifth of the market price of oil multiplied by the number of barrels believed to be recoverable from the property.

Reduction of Risks. Every business has its hazards; even banking is exposed to burglars, robbers, and swindlers. Farming runs risks from droughts, frosts, floods and fires, and insect foes. But no other industry is looked upon as quite so hazardous as mining, whether measured in terms of money, efforts, lives or limbs. In general, largely because of differences in their natural occurrence, the degree of *financial* risk within the mineral industry is least in quarrying building materials, making cement, liquid mining of salt and sulphur, and strip mining of coal. Natural gas, iron, copper, lead, and zinc are much less risky to the ordinary investor than are silver, gold, petroleum, and precious stones.

In the case of oil finding and production the element of risk influences failures perhaps more than the questions of costs and wastes. Several kinds of risks enter into petroleum operations as a branch of the mineral industry. They include, (1) *natural hazards*, geologic* more than geographic and climatic; (2) *physical* or *mechanical*; (3) those purely *financial*; (4) *commercial-economic*; (5) *human* hazards affecting life, limb, and health. These differ in degrees according to the stage of operation: (1) Finding or wildcatting; (2) development or drilling for production; (3) production; (4) transportation, especially by tanker; (5) refining; (6) marketing; and (7) utilization. Then there may be considered, furthermore, the classes of people concerned, such as (1) the investors; (2) the pioneers and honest promoters; (3) the professionals, including geologists and engineers; (4) the employe; and (5) the consumers.

Cutting Down the Costs. This may be accomplished by the lessee having ample time to prepare for drilling; by selecting the proper equipment; by employing a conscientious contractor, or competent drillers if the work is done by the day; by judicious buying of used but serviceable machinery, tools, and supplies; by avoiding superfluous overhead expense; by promptly cementing water sands; by operating in settled districts during normal periods.

HOW TO WIN IN WILDCATting

The financial perils threatening established enterprises in production, transportation, refining, and marketing have been touched upon in the preceding chapter. Since the largest losses to ordinary investors are

*One remedy for failure is to study painstakingly the geologic structure in the oil-bearing beds as revealed by well records; to determine the shape, outline, and position of the anticlines; and then to determine the relation between the structure far below the surface and that at the surface. Some of the strong companies have undoubtedly made such studies, but most of them guard jealously such information as they have obtained. The United States Geological Survey, Department of the Interior, is furnishing some assistance in the exploitation of the oil and gas resources of the country by publishing reports describing in detail the surface rocks in promising areas and containing maps showing the structure of the beds. These reports are sent from the Geological Survey at Washington to anyone requesting them.

incurred invariably in the preliminary stages, special attention will here be paid only to the risks relating to the finding and developing of oil and gas deposits. However, accompanying illustrations and references for readers cover such other subjects as "Fire and Explosion Hazards on Sea and Land,"* "Safety in the Petroleum Industry," etc., which pertain to the going concerns among which failures are comparatively infrequent. There are several steps that may be taken to insure success in drilling for oil.

1. Employ a reputable geologist. Of wells located at random, even in attractive territory, not over 5 percent prove productive; of those scientifically located, 85 percent succeed. The prospector, not led by signs or science, has about one chance in one thousand of striking oil.

2. Give this geologist a chance to choose from several tracts, or if but one area is under consideration give him time to investigate the surface signs. A thousand dollars thus brings better results than ten thousand devoted to a dry hole.

3. If these signs do not definitely evidence the oil structure (with or without complete closure) which is suspected to exist, then arrange for shallow structure testing with core drills with three or four holes as the minimum.

4. If blind wildcatting is preferred, give yourself at least one chance in twenty by drilling neither in granitic nor in lava rocks and by locating all tests in sedimentary or stratified rocks neither too old or entirely flat.*

5. If staking all on one test favorably located, "drill deep or touch not the petroleum spring." Be sure before abandoning the attempt. A difference of a dozen feet often spells success or failure.

6. Be sure your funds in sight suffice for completing at least two or three tests if operating in a promising area. Control can easily be lost at critical times, and minority stockholders can be readily frozen out.

7. If the choice is yours, prospect in a major field where the oil is of high gravity or rich in gasoline content. Your product may be worth a premium if you strike oil.

8. Do not acquire a leasehold at the very peak of excitement and speculation near a newly discovered field. An exorbitant bonus or excessive royalty may make your venture unprofitable.

9. Do not wildcat out in the wilderness where costs of development are prohibitive and where markets and marketing facilities are absent. The San Juan field in southern Utah is a case in point. Those who years ago found oil there have yet to receive any returns.

10. Lease up as large an area as possible (without rentals) for your own protection so as to cover the entire structure if you are wildcatting on the strength of a real geologist's favorable report. If possible, do this before spudding in or even erecting the derricks; certainly before drilling very deep. This will permit subleasing to yield profits in various ways, as through over-riding royalties.

*Serial No. 2400, September, 1922, by Katz and Smith, of the United States Bureau of Mines, is one of these. A general article by H. Foster Bain appeared in the *Oil Weekly*, December 9, 1922, others in the issues of December 22-29, 1924.

*Sixty percent of the United States will not produce oil under any circumstances—simply is not made of the right stuff. Out of the remaining 40 percent of the 2,000,000,000 acres of land 98 percent, or 784,000,000 acres are not built right to produce oil, or in technical language is "off structure," according to the consensus of American petroleum geologists.

11. Save the rock cores, or have the well log kept as perfect as possible and certified to by both the head driller and the geologist, so that you may induce a substantial established operator to take hold of your enterprise if the showings are attractive without actual production and if your experience or capital, or both, do not suffice for success. Your retained interest, in whatever form, may be made highly profitable without further risk and trouble on your part.

12. Do not drill into the highest spot of the suspected or outlined structure, for several reasons. One is to avoid early exhaustion of the natural-gas pressure so essential to maintain flowing wells from points further down on the structure.

13. Put down drill holes well away from property lines to avoid the waste and expense of drilling many offset wells and otherwise, too, avoid close spacing which may eat up profits in the event oil is discovered and you begin development campaign.

14. Keep costs down in the discovery stage by employing preferably a core drill, and in general thereafter by contracting for the development. The former should eliminate the usual heavy expense for casing and the latter will roughly limit the costs. See also points 9 and 13. Remember, you can prove a structure with three or four core drill tests at less than one-third the cost of one ordinary deep test with cable tools or at less than one-fifth the cost of a deep test with rotary tools. You can probably outline the limits of an entire small structure with 10 or 12 shallow tests for the cost of one deep well.*

Wastes in Wildcatting, especially of capital, count for much more than in the producing stage. Here are a few helpful suggestions to honest and conscientious wildcatters. Do not sacrifice a large part of your capital in paying big commissions for the sake of an early start in drilling. Choose a favorable season of the year or a region where you need not waste half your capital on road building. In fact, avoid making any permanent improvements if possible until after you have made a substantial discovery. Do not offer free trips to stockholders, and curb your own curiosity in the event that your operations are far away and you have dependable drillers. Make no effort to bring in a well until you have facilities for control or for storage and transportation; otherwise you may waste enough oil or gas in a few days to pay for a year's experienced efforts..

BLUE SKY LAWS

There are fashions in swindles just as there are in milady's frocks. It is hard to sell gold mining stock in an oil year, just as it is difficult to dispose of shares in a sugar-growing corporation at the time when the fish are biting most freely on cord tires.

* "Diamond Drill a Wildcat Aid," M. O. Danford in the *Midwest Review*, 1921.

"Barrels of Money and Plenty of Nerve."—*The Oil & Gas Journal*, September 13, 1923. (A 6,680-foot dry test of the Standard Oil Co., of California cost \$300,000.) "Developing a Property for Sale to Professional Operators."—Story of how Edgar B. Davis discovered Luling, spent a million after abandoning a \$75,000 dry hole, but produced nearly 10,000,000 barrels of oil before the middle of 1924. See *The Oil & Gas Journal*, June 5, 1924, pages 123-4.

"Hints on Oil Prospecting," surface indications and manner of occurrence, where found, the best place to drill.—Press Notice, No. 14, 117 U. S. Geological Survey.

"Petroleum: Where and How to Find It." By Anthony Blum, 367-page book. D. Appleton & Co., 1922.

"Hints to Stock Buyers," in Bulletin No. 116, Oil Series No. 4, by G. M. Butler and M. A. Allen, University of Arizona, Tucson, 1921.

Excusing the Existence of Charter Mills. All kinds of defences are offered for the existence of the charter mills in Delaware, Arizona, and one or two other states; principally, however, Delaware. Delaware issues charters at the rate of about 5,000 a year, of which it has been estimated 98 percent do not survive five years. They last just long enough for the promoter either to sell all of his stock or to realize that he has not picked a winning scheme. A great many states have organized security commissions which popularly are termed blue-sky commissions because their purpose is to prevent the swindling stock salesman from selling the blue sky to the credulous. States that have advanced to this point are a reproach to such states as Delaware, for when you get right down to it the blue-sky commissions in this country could cease functioning tomorrow if every Delaware and similar charter were wiped out. The blue-sky commissions, in fact, represent the arming of the state to protect its citizenry against the invading robber.

Protection in Particular for Impecunious People. We need not worry about the rich widow who is taken in by a spiritualist confederate of a ring of crooks, or the retired manufacturer who drops \$50,000 or so in a stock swindle. Whom we should worry about is the small (or nonunion) wage earner who is concerned with the future of his family. He scrimps and saves. He makes up his mind to invest his money so as to have an independent income in his old days. He gets a nice little nest egg together. It is not merely a little hoard of dollars; it represents the sweat of toil, frequently the suffering that comes from self-denial. Then comes the glib-tongued promoter with his window display—and the nest egg is gone!

Retail Dealers Require Defense. The small merchant, the corner grocer, the butcher, the baker, the candlestick maker, all these are interested in the campaign to wipe out fraudulent stocks and punish those who sell them. It is the business of every chamber of commerce and of other commercial organizations in the United States to keep close watch on the itinerant stock salesman. It is the duty of such organizations to appoint vigilance committees, extra-legal blue-sky commissions, to make inquiry and report upon every stock offering that may be made to the people within its community. Concerted action by all the chambers of commerce will drive the crooks away.*

Earmarks of Frauds include the following: (1) Large and flaring advertisements; (2) fancy office quarters during wildcat stage; (3) more stock salesmen than drilling wells; (4) promise of early listing on a stock exchange; (5) inability to produce an original favorable report by a reliable geologist; (6) effort made to stampede the investor; (7) exaggerated claims based on production of wells distant over 2 or 3 miles; (8) possibility of failure not admitted; (9) liberal quoting of successes in far-away fields; (10) display of expensive photographs of unrelated oil fields. Elaborate plans for refining mentioned before production is assured. Control

**The Magazine of Wall Street.* See also reference to the Better Business Bureau at the beginning and end of this chapter. The Investment Bankers Association is also active in educational campaigns to show investors how to distinguish between safe and uncertain securities. According to E. E. Shields, chairman of the Blue Sky Committee of the Pennsylvania Bankers' Association, the "backbone" of the law in the Keystone state is a clause which stops many promoters before they have a chance to operate. Two of its vital points relate (1) to an intentional failure to disclose a material fact, and (2) to any form of promotion fee or commission that is "so gross and exorbitant as to appear unconscionable and fraudulent."

retained by promoter without paying anything for leasehold or sharing materially in the drilling expense. Claiming chances of success exceed or even equal those of failure. Salaries paid to officials before production obtained. Dividends paid or promised within a very short time or before any oil or gas can possibly be produced. Claiming production on one or more sides of a leasehold for which no cash has been paid. Capitalization plainly excessive considering area of holdings and absence of production. Inability to give good, unprejudiced references. Withholding answer to such a query as "How much of the expected production do I get for my cash?"

Six Stock Salesmen to Be Avoided: (1) The man who tells how stockholders in similar concerns waxed wealthy over night; (2) he who wants your help in "keeping the deal away from Wall Street"; (3) he who talks about the "transferability" of the stock; (4) he who says the stock will later be "listed on the exchange"; (5) the one who wants you to buy because "the price is surely going up"; (6) the man whose chief selling points are letters of recommendation from "leading citizens."

Hammond's Ten Don'ts. John Hays Hammond's rules for investors in mining stocks, with the substitution of the word "oil" for "mining," are applicable and to the point in connection with the conservation of capital.

(1) Don't invest your money in an oil property simply because of the fact that a friend of yours became rich through a fortunate investment made in oil stocks. (2) Don't, on the other hand, be deterred from investing in an oil property because another less fortunate friend became bankrupt through some other oil investment. (3) Don't allow any insinuating, slick, dishonest promoter or so-called stock broker to overcome your natural modesty and convince you that, because you have been successful in your own line of business, you yourself are competent to determine the value of an oil property. (4) Don't be influenced in your desire to purchase oil stocks by a bottle of oil that the property has produced, even though you yourself have seen the oil actually on the ground. This is similar to specimen rock in a mine, which is not a criterion of the average grade of ore upon which the success of the mine depends. (5) Do not buy stock in an oil property because it has produced a profit of millions of dollars in the past, for the property is obviously so much poorer for the millions already abstracted. (6) Do not buy stock in an oil company simply because of the fact that its property adjoins another oil property of great value. That may be interesting, but it is not conclusive as to the value of the property in question. (7) Do not buy stock in an oil property solely because it is in a far-off country, even though distance lends enchantment to the view. (8) Above all, don't buy shares in an oil property unless you have the unqualifiedly favorable report made by an oil expert of known integrity, ability, and experience, and one who has made a success in investment of money for his clients. (9) Don't buy stock in an oil property unless you are sure that the board of directors are honest and competent, because good management is just as essential to success in oil production as it is in other enterprises. (10) In short, don't abandon all your good common sense just because the investment happens to be one in oil and not in some other class of securities.

"Each year over \$500,000,000 is lost in this country through fraudulent securities. 'Probably 30 to 40 percent thereof in oil affairs.—Author.) This huge sum goes largely into the pockets of swindlers. The most unfortunate aspect * * * is that much of this waste of hard-earned capital could have been prevented if the investment seekers had taken the trouble to make a proper investigation * * * or to consult some competent adviser before buying."—Andrew G. Mellon, in a letter, January, 1927, to Adolph Lewisohn, chairman, Nat'l Thrift Committee.

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Date

Full name of corporation

Location

Has the company or corporation operated under any other title?

Nature of the business?

OFFICERS

ADDRESS

President

Vice President, etc.

In what state incorporated? Date.....

Name and address of incorporators, number of shares held by each, and amount paid thereon:

Name	Address	Shares	Amount
.....

Name and address of directors, number of shares held by each, and amount paid thereon:

Name	Address	Shares	Amount
.....

Exact location of principal office

Name and official title of person or persons in charge:

Amount of capital stock authorized, \$. Par value, \$.....

Into how many shares divided? Preferred Common

How many shares issued and outstanding? Preferred Common

How many shares issued in exchange for services rendered?

What was the nature of such service?

What, if any, is the present indebtedness of the company or corporation (mortgages, bonds, notes, etc.)?

Were any shares issued for property acquired; if so, how many and to whom?

Names of individuals or corporations with stock sale contracts or underwriting agreements

At what price was stock actually sold?

Have any shares been assigned free? If so, how many, to whom, and for what purpose?

What is the total amount of money actually invested in the property and improvements?

Property? Improvements?

Has a dividend been paid on stock; if so, when, and in what amount? Cash or stock?

Has such been paid from actual earnings or from payments by stockholders?

In what manner was the original property acquired? From whom?

Purchase price paid?

Of what does the property now consist?

What is the present assessed value of the property? Real, \$.....

Personal, \$.....

Name of stock salesman Address

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Securities of well-managed oil companies have yielded handsome returns to their holders. Such sound oil enterprises should not be confused with promotions conducted only to unload stock in paper companies upon the public.

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Before sending funds to purchase "units of beneficial interests" or "participations in oil royalties," get facts as to the organization in question; find out what future personal legal liabilities may be involved in such participation; obtain information as to the powers of the "trustee" who operates such projects; and facts as to his business history and fitness to act as your trustee.

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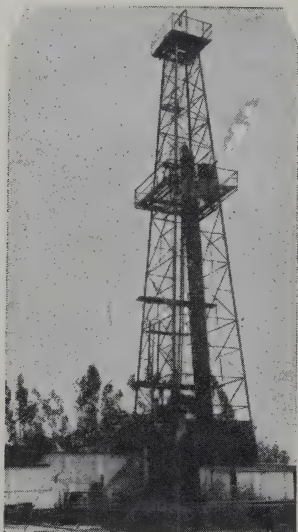
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INDEX

A

Abrams No. 1 well, The Texas Co., 162, 320.
 Absorption method, gasoline, 109.
 Accounting, uniformity in, 307, 314.
 Acre yield of some pools, 70, 366.
 Adv. Clubs of the World, Associated, 106.
 Agriculture, 9, 20, 61, 66, 119, 123, 136, 301.
 Airey, Richard (Shell Union), 16, 350.
 Alamo pool (Penn.-Mex. Fuel Co.), 226, 234-5.
 Alaska, 25, 253, 259.
 Alcohol, substitute motor fuel, 119.
 Algeria, French prospecting, 16.
 Allegany-Bradford field, 72, 367.
 Alsace oil mines, France, 16, 43.
 Amalgam of coal and oil, 99.
 Amarillo (Panhandle) pools, 33, 145.
 Amerada Corporation, 276, 320, 336, 367.
 America lubricates world's machinery, 181.
 America's coal resources, 204; oil, 19; oil production, 223, 233.
 American Academy of Pol. & Social Sc., 131; — Chemical Society, 280.
 American bottoms for oil exports, 172; — development abroad, 12, 207, 217, 222, 227; — Institute of Min. & Met. Engrs., publishers of *Mining & Metallurgy*, 11, 14, 35, 44, 47, 79, 89, 103, 113, 120, 200, 212, 214, 215, 216, 221, 236, 306-7, 308, 313, 317, 319; — Petroleum Institute (A. P. I.), outgrowth of Natl. Pet. War Service Committee, 299; see also 103, E. C. Clark (pres., 1927), Tom O'Donnell (1919-24), W. S. Farish (1926), J. Edgar Pew (1925), R. L. Welch (Secy.), and "Supply and Demand" (report by Com. of Eleven), 262.
 Amundsen's schooner "Maud," 17.
 Andian National Corporation, 217-18, 360.
 Andros, S. O., Petrol. Exten. University, 360.
 Anglo-Persian Oil Co., 12; refineries, 188-9.
 Animals, extinct, 5, 28-29.
 Anticline, anticlinal structure, 22, 24.
 Appalachian field, 22, 24, 31, 37, 39, 141.
 Appraisal committee, Indep. Oil Producers' Agency, 318.
 Appraising versus bookkeeping, 319.
 Appreciation through discovery, 319.
 Archbold, John D., 63.
 Archer, W. J., author, "Mexican Petroleum," 107, 208, 214, 225, 227, 230.
 Areas, comparison of shapes, 144; major fields, 39; oil states, 147; pools, 167.
 Argentina, 14, 19, 196, 198, 209-212.
 Arkansas, 26, 31, 33, 80, 98, 142, 149, 150, 158, 170, 233, 302, 323, 366.
 Armenia and Asia Minor, 9, 10.
 Arnold, Ralph, consulting geologist, 35, 71, 81, 254, 256, 279, 281, 299.
 Art Metal Construction Co., fireproof fixtures and furniture, 385.
 Asia, 7, 11, 14, 18, 19; see China, India, etc., 135.
 Assets, of the industry, 303; of independents, 348; of Gulf Oil Corp., 348; of Standard of Ind., 346; of states, 301-2.
 Associations: A. P. I., 299; A. I. M. & M. E., 131; Am. Petrol. Geologists, 311; marketers, 92, 315; Mid-Cont. Oil & Gas, 92, 117; also 41, 103, 117, 315.
Atlantic Monthly (Leo Pasvolsky), 7.
 Atlantic Refining Co., 355 (see Companies); — Seaboard, 21, 53, 88-90, 171-2, 175.
 Atlas of Commercial Geology, 22, 31, 94.
 Australia, 16.
 Authorities (see Chemists, Economists, Engineers, Financiers, Geologists, Lawyers, etc.).
 Automotive Engineers' Society, 119; — industry, unit output, 83.
 Averting tragedies, world, 10; investments, 370, 376.

B

Bain, H. Foster, secy. A. I. M. & M. E., ex-director, Bur. of Mines, 59, 285.
 Bakersfield, Kern Co., Calif., 138, 258.
 Balance sheet, crude oil business, 321; The Texas Co., 341.
 Baldwin Locomotive Works (Vauclain, 350), 367.
 Baltimore, oil port, 20, 88, 139; refining center, 170; tank building, 274-5.
 Bank relations, 302, 357-8.
 Barneson, Lionel T., 300, 331.
 Barnsdall, see under Companies.
 Barranca-Bermeja, Colombia 215-219.
 Barron, Clarence W., financial authority; pres., Dow, Jones & Co., pub. of The Wall St. Jnl.; founder of Boston News Bur. and Phila. News Bur.; 8, 164, 290.
 Barron's, 337, 343, 350-2, 358, 369.
 Bartlesville, Okla., 138, 249.
 Baseball comparisons 66, 272.
 Batavian Petroleum Co. 368.
 Bayonne, N. J., refining center 88, 139, 170.
 Baytown (50,000 bbl.) refinery, Tex. 348.
 Beal, Carl H., geologist, 250, 256, 281.
 Beaty, Amos L., 245, 283; chairman, The Texas Co., 338; address before Oil Board 268, 343, 361.
 Beaumont, Tex. (see Spindle Top) 40, 170, 304.
 Bedford, Alfred C., late chairman, Standard Oil Co. of N. J.; founder, A. P. I.; 10, 31, 298-9.
 Benedum, M. L. and J. C. Trees 217, 304.
 Beneficiaries 293-7.
 Benson, R. D., chairman, Tidewater 69.
 Benzol, gasoline substitute 119.
 Bergius, F., (see Hydrogenation).
 Better Business Bureau 363, 370, 381, 383-4 (see Nat'l Vigilance Committee 106).
 Bibi-Eibat field, Russia 26.
 Big Lake 142, 162, 166; see Reagan Co.
 Biggest buyers, U. S. oil 184; Mex. oil 241.
 Bird's-eye view 264, 301.
 Bjerregaard, A. P., chemist 280.
 "Black Golconda," Marcossion's 244, 252, 295.
 Blair, David H., Com'r Int. Rev. 248.
 Blardone, Mex. authority 224, 232.
 Bolivia poorly situated 208.
 Bonded debt, companies without 361.
 Bonds and stocks (see Securities).
 Bonuses 306, 310-11, (Osage County) 315-6.
 Boston, oil port 20, 139.
 Boston News Bureau 77, 290, 321, 324.
 Bottom settlements "b. s." 54.
 Bowles, Chas. E., asst. sec'y, Mid-Cont. Oil & Gas Assn. 169, 302, 360.
 Bradfordfield, McKean Co., Pa. 72, 145, (see Bradford-Allegany 366).
 Branner, J. C., late Calif. geologist, 209.
 Brazil, unexplored area, etc. 209.
 Brenner, H. H., Pawhuska banker 295.
 Bridge, Dr. Norman 291-2.
 British authorities; Cadman 11; Cowdray 278; Cunningham-Craig 23; Curzon 17; Liggett 87; Redwood 227; Waley-Cohen 316 director, Shell Union 350; see also Oil News and Petroleum Times, London.
 British development 213, 222, 228.
 British India, see India.
 British petroleum trade 187-90, 369;—wild-cattling, capital expended in, 16.
 Brown, Robt. W., val. engr., author 318.
 Bryan, John C., 63; Barnabas 206.
 Burbank field 79, 142-5, 160, 295, 366 (see Marland and Osages).
 Bur. of For. & Dom. Com see Foreign.
 Bureau of Mines, see Mines.
 Burkburnett, Tex. 62, 64, 143, 164, 166.

INDEX

Burrell, Col. Geo., chemist and nat. gaso-
line producer 226, 251, 280.
Burton, W. M. ex-pres., Standard Oil Co.
of Ind. (cracking process) 107, 280, 346.
Buyer of crude, world's biggest 175.
Byles, Axtell J., pres., Tidewater and T.
Associated 330.

C

Cabin Creek, W. Va., (see Pure Oil Co.)
267, 352.
Cadman, Sir John 11.
"Caesar's Tax" by Benj. L. Dulaney 386.
Caetani, Don Gelasio 61.
Calcasieu parish, La., see Edgerley and
Vinton pools 70, 163, 166, 167.
California 2, 5, 16, 21, 24, 25, 28, 29, 31,
33-35, 39, 40, 42-45, 51-53, 55, 57, 59, 66,
69-73, 75, 77-81, 86, 88-90, 92, 96-7, 100,
105, 108, 111-2, 115, 118, 123, 127, 133,
135, 138, 139, 142, 145, 150-7, 160, 208
(comparisons) 220-1, 231-3; fuel oil dis-
tribution (map) 153; 233, 243, 254, 302-3,
305, 365 (see Los Angeles and oil fields).
Calif. Institute of Technology 291.
Calif. Mining Bureau 40.
Camels in asphalt, Rancho LaBrea 5, 29.
Canada 15, 28, 38, 53, 63, 130, 302.
Canadian Bureau of Statistics 302.
Canal, see Panama.
Capacity, 8-inch pipe line 54; Mexican stor-
age 233; reservoirs 80; steel tanks 52.
Capital assets, companies 303-4; divisions
303; industry's total 303,358.
Capital, at various times 356; comparisons
357; method of procural 358; new, need-
ed per annum 305-6, 357-8; outlay, an-
nual 306; returnable as depletion 321;
total invested 302, 357; unreturned, crude
business 305.
Cap rock, see impervious beds 23.
Cartagena and Mamonal, Columbia 217-8.
Carter, Col. J. J. 63; county 160.
Cash ten independents, 348.
Casiano Mexican gusher 229-231.
Casing 49, 51; cost of, 309.
Casinghead gasoline 109, 158.
Casper, Wyo., 135, 139, 170.
Cementing wells 41.
Center of production, U. S. 136, 157.
Central America 207.
Cerro Azul, gusher 229-30, 300.
Chamber of Commerce, U. S., 181, 195;
ex-pres. Julius H. Barnes 20; committee
on business ethics 272; ex-pres. R. F.
Grant 328; charts 180, 182, 185.
Chamber of Mines & Oil, Calif. 34, 79
(see Oil Bulletin, cred. with data and
illustrations).
Character of oil men 274, 284.
Characteristics of crude 22; see Quality.
Cheapness of gasoline 114-117.
Chemically controlled industry 84.
Chemistry 22, 57-9, 107, 369.
Chemists 57, 59, 119, 280, 282; see Bjer-
regaard, Burrell, Burton, Leslie, Little,
Loomis, Rittman, Slosson, Stowell, Wil-
son.
Chester concession 10.
Chief products 59, 60, 82, 83, 86;—sources
of U. S. imports of crude 200.
Chili, chief So. Am. coal producer 208.
China 15, 182-4, 186, 191-2.
Cities and oil towns 20, 63-4, 135, 138-9;
capital of oildom 136-8; import traffic
139; refining centers 139, 168-170; see
also Amarillo, Bakersfield, Bartlesville,
Bayonne, Baytown, Beaumont, Bradford,
Burk Burnett, Cabin Creek, Casper, Cleve-
land, Corsicana, Destrehan, El Dorado
(Ark.), Eldorado (Kans.), Fall River
90, 170; Fullerton, Ft. Worth, Galveston
139, Houston 135, 138; Lima 138, Long

Beach, Los Angeles, Luling, Marcus
Hook (Phila. district), New Orleans, New
York, Olean 355, Parkersburg 138, Pauls-
boro 355; Pawhuska, Philadelphia, Pitts-
burgh, Port Arthur, San Diego, San
Pedro, Seattle 17, Shreveport 138, Tam-
pico, Titusville, Toledo, Tulsa, Washing-
ton, Wichita 138, Wichita Falls 135, 138,
Wood River 139.
Cities Service (Doherty interest) 367; (see
Crew-Levick and Empire Gas & Fuel).
Clapp, Fred'k G. 254, 281.
Clark, E. W., v.-pres., Union Oil Co. of
Calif., 112, 349; pres. (1927), Am. Pet.
Inst. 300.
Coal, Army mines, Philippines 43, 44;
Association with oil 26, 99; Canada 38;
carbon ratio 26; compared with oil 97;
discovered in oil drilling 30; industry
overcapitalized 42; origin of, 30; Pitts-
burgh seam 30.
Coalinga, Calif. 154, 156, 160.
Colombia, American capital 217; 90 per-
cent of So. America's coal 208; coming
important oil producer 214; development,
Baranca-Bermeja district 215-7; im-
mense mineral wealth 217-9.
Colorado 36, 148, 150, 170, 340.
Comar Oil Co. 351-2.
Commerce 171-200; see Exports, Imports,
Oil ports, Trade.
Commerce Reports, U. S. see Dept. of Com.,
Bur. of Dom. & For. Com.
Comodoro Rivadavia 202, 210, 211, 212.
Companies, assets 303-4; bond liabilities
361-2; capital 344; current assets, ratio
to current liabilities 364-5; dividends
337-8, 340, 343, 367; earnings, net 335-6,
367; gross income 334-5; inventories
(mdse) 346, 348; mergers 329-31; net
profits 335, 167; securities 361-4, (listed,
7 bil. dollars) 365; tankers 345; who's
who 303, 335, 367.
Companies, Amerada Corp. 336, 337 (see
Amerada Petroleum Co., DeGolyer, pres.,
276) Asiatic Petroleum 16; Associated
330, 336; Atlantic Refining 304, 335-6,
355; Barnsdall 11, 304, 329, 336; Cali-
fornia Petroleum 304, 335-7, 367; Carter
316 (see Standard, N. J.), Chanslor-
Canfield 310; Comar 351-2; Continental
116, 304; Crew-Levick 356; Dixie (Stan-
dard, Ind.) 319; Empire Gas & Fuel
304, 306, 348, 367; Galena-Signal 364;
Gen'l Petroleum 105, 304, 329, 335-6;
Gulf Oil Corp. see gen. index; Houston
Oil 336, 362; Humble see gen'l index;
Imperial Ltd. 213, 217; Independent Oil
& Gas 364; Lago Petroleum 351 see also
Pan Am. P. & T. Co. and Venezuela;
Magnolia 359 see Standard, N. Y.; Mar-
land 304, 364-5, 367; Mid Continent
(formerly Cosden) 304, 335, 362, 364;
Midland 310; Mountain Producers 335,
365; Ohio Oil 304, 335, 346, 367; Pacific
Oil 329-30; Pan American Petrol. &
Transp. see gen'l index; Phillips Petro-
leum 304, 335-7, 354, 361-2, 367; Pan
Am. Western 304, 351, 365; Prairie Oil
& Gas 304, 324, 335-8, 364, 367; Prairie
Pipe Line 304, 364; Producers & Re-
finers 304; Pure Oil 267, 304, 352, 364;
Salt Creek Producers 336, 365; Seneca
63; Shell Union 304, 335-7348, 350, 364-5,
367; Simms 336, 364-5; Sinclair 304,
335-7, 348, 361-2, 365, 367; Skelly 304,
336, 362-5; South Penn 337, 365; Stan-
dard, Calif., 115-6, 118, 303-4, 328-39,
333, 335-8, 346, 362, 367; Standard, Ind.
116, 304, 335-8, 343-6, 364, 367; Standard
Kan. 116; Standard, Ky. 304, 335-8, 364,
367; Standard, La. 116; Standard, Neb.
116, 335; Stand., N. J. 304, 335-8, 346,

INDEX

364 (see Humble); Stand., N. Y. 116, 304, 331, 335-8, 362, 364, 367; Stand., Ohio 304, 335-8, 367; Sun Oil 304, 335-7, 353, 355, 362; Texas Pacific Coal & Oil 164, 331; The Texas Co. (see gen'l index); Tidewater 69, 304, 329-31; 335-7 367; Transcontinental Oil 217, 304, 336; Transcontinental Petroleum 345 (see Standard, N. J.); Union Oil of Calif. 349-50 (see gen'l index); Vacuum 334-8, 357, 364-5, 367; Ventura Consol. 294; White Eagle 336.

Comparative growth 66; income 332; prices 114, 115-7.

Comparisons, Calif., Okla., Texas 168; Mexico with Ark., Calif. and Gulf Coast 233; natural gasoline production 158; producing countries with states 1924-1926, 147; trade in leading commodities 176, 179.

Competition, Calif. vs. East 78, 365.

Competitive drilling 68, 79, 246, 306; production uneconomic 91, 100, 264.

Concentration, Mexican oil 225, 237; mineral production 167.

Confiscation threatened 244.

Congress 78, 91, (Cameron bill) 246.

Conservation 5, 40-3, 66, 79, 97, 99, 101-2, 105-6, 121-6; accomplished and required 259; Board 261 and its first report 264; encouraged by good prices 317; through combinations 329.

Consulting engineers 250.

Consumption, crude oil 93-4, 322-3; gasoline 111, 113, 129-30, 318, 323; per motor vehicle 110-11, (map) 323; refined products U. S. 323, 366; world 191-2.

Control of prices, flush producers 75.

Coolidge, Calvin 127, 245, 261.

Cope, H. W., asst. dir. eng. Westinghouse 309.

Copper, Latin America 193; value, U. S. 63.

Core drilling 43-9; cost 311.

Corsicana Deep Well Drilling Co. 165.

Cosgrove, J. J., atty., The Texas Co. 321.

Cost factors 306, 314.

Costs, cable drilling 312-4; core drilling 311; development 312-4; equipment and supplies 308, 312; labor and management 307, 312-3; leases 316; leasing 310; lifting or pumping 314; producing 306, 314-6; reduction 378; refining 85; rotary drilling 312-4; transportation 85-90; varies with yield rate 315.

Cotton and corn, tonnage comparison 61.

Cottrell dehydration 52.

Counties; see Carter 160, Creek, Harris, Hutchinson, Jefferson, Kern, Los Angeles, Limestone 165, McKean, Natrona, Navarro, Orange 33, Osage, Ouachita Smackover f.), Reagan, Seminole, Yenang, Wichita and Wilbarger 164; also maps 145, 149, 159, 163, and table 168.

Cowdray, Lord 228, 278.

Cracking process 57, (Burton) 107, 280, 346; (Dubbs) 334, 352; (Holmes-Manley) 340.

Crawford, Geo. W. (Transcontinental Oil) 217.

Creek County 42, 88, 160; see Cushing.

Cretaceous 26, 27, 28, 200-1, 231.

Crew-Levick Co. (Cities Service) 356.

Cromwell pool 142, 144, 161.

Crude oil, making money out of 324; stocks 81, 82, (supply and demand) 318, 367 see consumption, exports, imports, production.

Cuba, richer in ore than in oil 205.

Curacao, Dutch West Indies 207.

Current assets (cash and mdse) 241, 246, 348; ratio to cur. liabilities 359; less current liabilities (working capital) 343.

Current production, see production; supply and demand 322-3; 3 sources, cur. supply 322.

Currie, Sir James T. 222.

Curtis Publishing Co. 297; see Sat. Eve. Post.

Curzon, Lord 17.

Cushing, light oil district 33, 42, (output to 1925) 161; cementing 41; life of, 69, 78, 88, 142-3.

Cuts or fractions in refining 54.

D

Daily rate 16, 68, 69, 71, 86, 94, 105, 142-3, 146, 148, 155-6, 158, 170, 217, 222, 230-1; peak, 1926, 1927, 368-9.

Darnell, Jas. L., val. engr. 71, 318.

Davis, Dwight, Sec'y of War 130.

Davis, Edgar B. of Mass., founder, United No. & So. Oil Co., Luling, Tex., 166, 277.

Davis, James J., Sec'y of Labor, 49.

Davis, W. N., pres., Mid Cont. Oil & Gas Assn., 92; 298 (Phillips Petrol. Co.) 354.

Davison, Geo. S., pres., Gulf Refining and (1926) Am. Soc. Civil Engrs., 130, 267, 283, 298.

Dawes, B. G., chairman; H. M., pres., Pure Oil Co., Chicago, Ill., 352.

Day, David T., late geologist, author, "Day's Handbook" 43;—Roland B., "Increasing Income," 335.

Deans of geologists, 65, 281.

Death rate, accidents, 284.

Decrease 30 mil., Calif. output 142; U. S. output 1924, first since 1906, 144.

Deep drilling, 30, 48, 51, 73, 156, 307.

Defense, national, 130; industry 117.

Deficits (under Net income) 334; dividends from, see Depletion 319 (Boston News Bur., Aug. 20, 1926).

DeGolyer, E. L., geologist, pres., Amerada Corp. and Am. Inst. Min. & Met. Engrs., 254, 276, 281.

Dehydration 52. Demand, see consumption.

Denmark, 180, 182, 185, 186.

Dennison, C. S., globe-trotter, Texas Co., 338.

Departments, U. S. Government—AGRICULTURE, 119; COMMERCE, Bureau of Census 82, Navigation 90, Standards 101, Bureau of For. & Dom. Com. and Mines 248-51, 252; INTERIOR, cosmopolitan character Bur. of Education 127; Indian Office 6, 41, 252, 257; Land Office 252; See also Geological Survey; JUSTICE, Attorney General 106; LABOR 49-57, 313 (see James J. Davis); NAVY, 95, 130; buying and storing supplies 257; increasing call for liquid fuel 257; underground reserves 245, 259; POST OFFICE (Harry S. New, P. M. Gen'l) 106; STATE 12, (ex-Economic Adviser, S. K. Hornbeck) 19; TREASURY, Bur. Int. Revenue 248, 31, 71, 226, 316, "Statistics of Income" 325, 333 valuation engineers 81, 71, (Natural Resources division) 6; WAR (U. S. Army coal mines and corps of Engrs.) 43, 44, (Sec'y Davis) 130, Army trucks 257. See also Federal Oil Conservation Board, Fed. Trade Commission, Fuel Administration, Nat'l Museum, Shipping Board, and Supreme Court.

Depletion of natural resources 19, 101, 136, 306, 321; deduction before income tax 321; latest laws, 1924 and 1926, 322.

Depreciation, physical assets 306, 312.

Depth, drilling 40, 68; production 72-8, 105, 166; producing sands, major fields 33-38.

Desert drilling 64; filling station 92.

Destrehan, La., refinery, Pan Am. 170.

INDEX

Deterding, Sir Henry W. A., man. dir., Royal Dutch, dir., Shell T. & T. Co., chairman, Shell-Union Oil Corp. 350, 369.
Determination of net profit 334.
Diesel engine 17, 65, 95, 102, 242.
Discount for risks and time 377.
Distress prices 75, 78, 90.
Dividends 338, 344; from deficits 321; more regular 337; Standard totals 338, 368; Texas Co. 340.
Divisions of the industry, Finding and developing 43-51, 67-68, costs 311-3; Producing 51-2, 68-74, 303, costs 312-14, income 332-3. Transporting 51-54, 98-90, (storing) 80-81; 303; Refining 54-60, 82-86, 303, 335, 378; Marketing 91-99, 113-118.
Dixie Oil Co. 161; see Standard of Ind.
Doheny, Edward L. 228, 292, 310; brought billions to surface 278; California on oil map 291; Cerro Azul 230, 300; established Mexican industry 227; supreme knowledge 276; "Martyr we made you" 173; Mex. fuel oil in war (Arnold) 299; Naval Reserve 247; Peruvian pioneering 213; pre-eminent pioneer 278; war oil committee 298; world's foremost wild-catter 278-9.
Doherty, Henry L., chairman, Cities Service Co., advocate, unit plan 130; 299, 306, 326.
Darnell, J. C. late pres., Ohio Oil Co. 271.
Dome oil structure 24.
Domestic doings in 1926, 326, 368.
Domestic production, exportation 136-187.
Dominance, United States 15, 233.
Dos Bocas, Mexican gusher 228.
Drake, "Colonel" E. L. and first well 63, 101.
Dralle, N. E., Engr., Westinghouse 309.
Drilling costs 310-12; methods, cable 30, 49-50; core 44, 46-9; rotary 41, 44, 50, 68.
Dry-hole hazard 244, 306; dry holes, number 311.
Dubious attitude, Latin America 10, 202.
Dumble, E. T., dean Western geologists 281.
Dutch East India 14, 15, 18, 103, 191, 192.
Dynamiting eastern markets 78.

E

Earmarks of fraud 381.
Earnings, gross 334; sales 336; net, 334-5; companies (profits) 337, 367.
Eastern states 146.
East India, see Dutch E. I. and India.
Eaton, J. E., geologist, 328.
Economic geology 14, 22-301, 200-2, 225.
Economics 61-128; 6 fact groups 68.
Economic limits 69-70; evolution, Calif. 154.
Ecuador 208.
Edgar, Sir E. Mackay, chairman, British Controlled Oilfields 18.
Educating gullibles, great safeguard 370.
Efficiency of industry 40, 61-2; employees 273.
Electra and E. district 142, 164.
Electric drilling cheaper 309.
Electrification, field and refinery 309.
Elements, cost, comprehensive 306.
Elk Hills, Calif., 155-6, 258-9.
Emmons, W. H., "Geology of Petroleum" 23.
Empire Refineries 280. See Empire Gas & Fuel Co. under Companies.
Engineering aspects 40-43; conservation through 101.
Engineers, Geo. S. Davison 130, 283; diplomats 11; Gov't as 245; production 42, valuation 31.

England, modern tanker built 88 (see Brit.)
Enterprise, U. S. in South America 194.
Eocene, a Tertiary epoch 27.
Equipment and supplies, standardization 66, 307.
Europe and European countries 14, 16, 17, 19, 141, 147, 195-6.
Expenditures, annual, 306.
Expense, see cost; sources 314.
Exploration 22, 30, 43-49, 253.
Exportation not depletion 187.
Exporter, U. S. the leading 179.
Exports, by classes 179, 369; distribution 180, 182-7, (non-oil) 196; position of petroleum 178-9; 24 leading 179; relation to production 186; tonnage of 10 exports 174.
Export trade, Federal restrictions 178; importance of maintaining 177-8; Mexican 238-40; oil greatest force 177; patiently built up 178.
Export traffic of oil ports 189.
"Evolution of the Oil Industry" 301, 305.

F

Fact finding 376.
Factors, cost (elements) 305-6; economic 68; equipment and supplies variable 312; human 272; in rapid finding and developing 105.
Failures, causes 374-6; prevention 376-8.
Fall River, Mass. 90, 170.
Fanning, L. M. 154, 306; N. O. 67, 88, 154, 357-8.
Farish, W. S., pres., (1926) Am. Pet. Inst., pres. Humble Oil & Rfg. 105, 130, 369.
Farmers 20, 301; farm labor diversion 63.
Fatalities 284-5, 367.
Fath, A. E., chief geologist, Vacuum Oil 281.
Fay, Albert H., val. engr., (head, Natural Resources division, 1921-3) 31, 49.
Federal, see Governmental; bureaus, see Departments, Geol. Survey, Mines; Government greatest single consumer 245; Oil Conserv. Board 261, report of Trade Commissioner 65, 78, 85, 91, 92, 103, 104, 246.
Federal Council, Churches of Christ 98.
Fee ownership 20, 123, 359.
Fields, major American 31, 141; see Oil fields.
Fifteen best customers 196.
Financial, bird's eye view 301; deficit, crude industry $4\frac{1}{2}$ billion, 303; influence and integrity 302; losses and conservation 324-9; position, Gulf and Humble 348; problem of storage 323-367; stabilizing; storage function 81, 324; success essential 301; treasures and tragedies 305.
Financial World 103.
Financing the industry 356; capital invested, comparisons 357; current requirements 356; expansion 356; how done 357; increase in capital of companies 358; sudden need for new capital 356; surplus, treble purpose 358.
Financial policy, raising capital, 356; rearrangement, largest 368.
Fire losses and prevention 327-8.
First tanker of Colombian crude 172.
Fisher, Cassius A., 263, 281.
Flooding or water drive 43, 72, 367.
Flush vs. settled production (ratio) 69, 266.
Fohs, F. Julius, ex-chairman Petrol. Sec. and Vice Pres. Am. Inst. Min. & Met. Engrs. 70, 145, 163, 164, 165, 166, 168, 277, 281, 310, 324.
Folsom, D. M., Gen'l Petrol Corp. 154.
Food from petroleum 59.

INDEX

Ford, Henry, 290 inventor, with business ability 278; on fraud prevention 370.

Foreign bottoms, American exports in 172.

Foreign and Domestic Commerce, U. S. 12, 16, 61, 68, 101, 120, 162, 171, 176, 177, 194; see Dept. of Com. or Com. Reports.

Foreign commerce, leading nations 195, U. S. tonnage 174; U. S. Value, imports 178, exports, 179, by countries 196; mineral oil 175-187. See Bur. of Dom. and For. Com., exports, etc.

Foreign consumption 15, 129-30, 191, 192; nation's efforts to find oil 16-17; production 14, 19, 140-1, (1926) 147. See also World consumption, etc.

Foreign ownership, U. S. oil 103.

Forms of assets 302-3.

Fortunes, service of 278.

Fox, Homer S. 184, 191, 249, 368.

France 8, 10, 14, 15, 16, 43, 119, 184-6.

Friendly competitors, Wortham Tex. 277.

Fraud evil arousing wrath 370; perpetration 370-9; prevention 380-3; punishment 106.

Fuel administration, see Requa 76.

Fuel and power, cost factors 309.

Fuel oil, California 153; comparison with coal 97; largest fuel oil contract 368; prices 93, 97; recovery from crude 60, 85, 86; stocks 82, 366; utilization 96. See Gulf coast and Mexico.

Fullerton, Calif. 35, 155, 265.

Furnace oil, growth in use 99, 368.

G

Galicia (see Poland) 14, 19, 140-1, 147.

Garber pool 78, 142, 366.

Garfias, Valentin R., mgr., foreign oil dept., Cities Service Co., 147, 281.

Gas, see Oil & Gas fields, Natural gas, W. Va.

Gasoline, casinghead 60, 109, 158, 360; change in demand 84, complete combustion 122; cracking process 57, 60, 107, 270, 367; criterion of quality 107; demand and supply, 111, 367, 113; distillation range 59, 106, 124; economic factors 126; exports 109, 179, 180, 184 (fig.) 323, 367; marketing 115-6; mileage per gallon 125; prices 114, 116-7, 366-7; profitable production of natural g. 360; raising boiling point 124; recovery increasing 60, 85, 86, 110, 366 (see Standard of Ind. and The Texas Co.); relief train 112; sources 107, 366; war relations 59.

Geographic center of production 136; g. sources of production 142-147, 361; distribution of reserves 19, 39, of invested capital 301, 302, of The Texas Co's operations 339, Standard of Ind. 344-5, of Standard Oil markets 116; significance of Calif. fuel oil, 153.

Geographic range, drilling costs 313; gravity 142.

Geography, commercial, chapters VIII, IX, X; physical, chapter III; see Maps.

Geologic column, U. S. G. S. 27; distribution 26; science essential 40, 310 and inexpensive 310.

Geological distribution 26-28.

Geology, commercial 31-38; economic 22-30; historical and stratigraphic 26-28; genetic 22-23; structural 23-24, 225; Latin American 200-2.

Geological Survey 6, 12, 22, 25-7, 29, 31, 34, 39, 55, 63, 76, 82, 93, 94, 101, (G. E. Mitchell 6, 121), 251-5, (graduates) 281.

Geological work inexpensive 310.

Geologists, see Arnold, Bain, Beal, Branner, Brown, Clapp, Day, DeGolyer, Deussen (281), Dumble, Emmons, Fath,

Fisher, Fohs, Folsom, Heald, Hopkins, Jensen, Jester, Johnson (Huntley & Somers), Knapp, McCallom 280, McLaughlin 280, Marsters, Morris, Orcutt, Redfield, Richardson, Smith, Taff 281, Udden, Veatch, Washburne 281, Wegeman 281, White, Wrother, Ziegler, Hill.

George, H. C., Petrol. Dept., Okla. Univ. 309, 314.

Germany 14, 17, 141, 180-6, 191, 195, 196, Glennpool 33, 158, 160, 161.

Gorgas, Gen'l 194.

Governmental activities beneficial 246; assets 259, 260; benefits 2, 5, 6, 7, 9, 246, 249; bureaus see Departments, Bur. of Mines, Geol. Survey; cosmopolitan character of work 245, 251; conservation of capital 41, 250; contributions (com. Dept.) 248-9; discoveries, surveys 252-4; economics 61, 62, 93, 101, 247, 257, 260; income 19, 247-8; needs and the Navy 256-9; position on mergers 329; regulations 245-6; treasures vs. tragedies 247.

Government, U. S. consumer 95, 245, 257; consulting engineers 245; factor 245; guardian 252, 260; helped by oil 247; land owner 245, 260; operator 245; publisher 245 (see footnotes referring to the "Manual for the Oil and Gas Industry" and other publications); statistician 15, 60, 63, 65, 76, 81, 83, 85, 90, 94, 109, 111, 140-2, 147-150, 157-8, 170-2, 174-6, 179, 181, 183-4, 186, 191, 195-6, 198-9, etc.; tanker owner 171, 256.

Grant, R. F., pres. U. S. Cham. of Com. 332.

Great Britain 8, 10, 11, 187-191, 368; see also United Kingdom.

Great gasoline marketer 344.

Greatest buyer 245; companies ("Who's Who") 303-4; depths 30, 309, 367; natural gasoline producer 354; wells 41, 151, 230.

Gross income, 317, 332; how to increase 333; twelve companies 335; The Texas Co. 340.

Growth, capital invested 357; crude production 66-7, (fig.) 140, 146; crude demand 94, 322-3; gasoline 109, 113, 323; Gulf Oil 346-7; refining 83; The Texas Co. 339.

Guffey, J. M., Petroleum Co. 346.

Gulf Coast 31, 36, 39, 41, 44, 70, 76-7, 162-4, 166-7, 366, 368.

Gulf Oil Corporation 41, 130, 137, 346-8, 361-2, 364-5, 367; comparisons with 3 other companies 343-4; thrifty 302. See Davison, Gulf Refining, Gulf production and Mellon.

Gulf Production 167, 310; Refining 267.

Gullibles need education 370.

Gypsy Oil Co. see Gulf Oil Corp.

H

Haig, Robt., v. pres., Sun Shipbuilding & Dry Dock (see Sun Oil Co.) 173.

Hammond, John Hays, see below and Mex. Seaboard (controlling Internat'l Petrol. Co.)

Hammond's Ten Dont's 382.

Harris County, Tex. 162, 164, 166.

Harvard University Committee 294, Economic Research 368.

Hazards, dry hole 244, 306; life, limb 284. See also Risks, chap. XIV.

Heald, K. C., staff geol., Gulf Oil 43, 254, 281.

Heating with oil 95, 99, 368; Governmental 257.

Helium 30, 251, (Petrolia) 164, (Burrell) 280.

High bonus, cost booster 306, 310-1, 315-6.

Highest oil field in world 212.

INDEX

High-grade pools, see Bradford, Burbank, Cushing, Glenn, Powell, Seminole, Tonkawa.
 Hild electric drive 310.
 History—Ark. 146, 149; Calif. 77, 146, 151, 156; eastern states 63-65, 76, 145-6, 159; economic, U. S., 63-7, 81, 84, 97-90, 92, 94, 96, 103, 109, 139-37 174; Gulf coast 36, 41, 162, 167, 320, (Spindle Top) 367; imports 174; Kansas 146; Louisiana 146; Mexico 227-30, 234, 236, (Tampico) 240; Okla. 32, 42, 146, 158-61; (Seminole) 366, 367; Pa. 63-4, 76, 145-6; Rocky Mts. 37, 69, 146, 349; tanker transportation 88-90, 172, 365; Texas 145, 146, 162-7, 366-7; three phases 270; West Va. 159. See also Gulf Oil, The Texas Co., etc.
 Holland, see Netherlands.
 Holmes, R. C., pres., The Texas Co., 238, 283, 342, 343; Holmes-Manley process 340.
 Hood, O. P., chief mech. engr., Bur. Mines 99.
 Hoover, H. C., 12, 245, 248, 261.
 Hopkins, E. B., (and Miss Jones) 220, 223, 281.
 House organs of companies 136, 288.
 "How to Run a Service Station" 361.
 Hughes, Chas. E., ex-Sec'y of State 173, 282.
 Human beneficiaries 293-7; annuities 287; big operators care for employees 285-7; institutions endowed 5, 291, 292, 296; employee stockholders 288; Farmer biggest beneficiary 122, 293; housing 286; mutual treasures 288; Osage Indians 294; service of fortunes 290; sick benefits 287; widening ownership 294.
 Human factors 272; characteristics of oil clan 274; correct conception, directors' burden 297; directors as dept. managers 296; driller, despot of the derrick 283; engineer and human element 283; fortune or failure 284; four able attorneys 282; geologist observe 280; hazards and heroes 284; high-minded men 297; industrial representation 287; intensive, not extensive 83, 272; ladders to leadership 281; labor troubles rare 273; lawyer-leaders 282; long lives of oil men 291; Mellon millions benefit householders 292; men who find through trained mind 276; neither nepotism nor politics 296; pioneers' supreme knowledge 276, preeminent pioneer in discovery 278; qualities of oil clan 274; reasons for high salaries 297; Stewart, Lyman, frontispiece, Part 1; stock ownership, employe 288; toilers intelligent 273; treasures 288, 293; war work of oil men 297.
 Humble Oil & Ffg. Co. 105, 130, (school) 287, 304, 328, 335, 336, 338, 343-4, (assets and securities) 346, 347-8, (Baytown refinery), 348, 361-2, 364. See also W. S. Farish and Standard of N. J.
 Humor, Osage Indian 295; other 60, 105, 251, etc.
 Humphreys, Col. A. E. 70, 164, 165, 278.
 Huntington Beach 34, 155, 156.
 Hutchinson County, Tex. 33, 145, 366.
 Hydrogenation of coal, Dr. Bergius 368.

I

Ichthyol 30.
 Ignoramuses prey on petroleum 371.
 Ignorance increases cost 311.
 Illumination, priority 95; Asia 135.
 Illinois 24, 28, 38, 72, 141, 147-50.
 Imperial Oil Co., Ltd. (of Can.) 213, controls Internat'l Petrol Co. Ltd. 213, 217 (see Standard of N. J.)

Imperial valley, Calif., 92.
 Importance, domestic industry 61, 301; foreign sources 7, 12-13, 66, 263, 265; foreign trade 177; geology and technology 40-1, 276, 279-81; Mexican Oil 241-3; Mexico and the U. S. 233.
 Import traffic of oil ports 139, 175.
 Imports, gain in refined 176; position of petroleum, tonnage 174, value 176; rise of rank, refined 177; sources, 200; where received 175.
 Income, companies 334-6; comparative 332; producing and refining 332-333; how to increase 333. See net earnings, gross 82-3.
 Income tax, large 346.
 Increasing gross income 333; profits by greater recovery 42, 267.
 Increase in crude output 72, 365; in imports 174; preventable in cost 315.
 Independents, see 103 and tables 304, 335, 343-4, 348, 367. See mergers, 329.
 India, British, 14, 18, 19, 184, 186, 191, 192.
 Indiana 38, 148, 150, 302.
 Indiana, Standard Oil Co., 116, 282, 288-9, 304 (Dixie Oil Co.) 319, 329, (gross) sales 335; net profits 335 and 367, per share 336; new world power 344-6.
 Inglewood, see oil fields and 366.
 Institute of Petrol, Technologists 328.
 Intercoastal traffic 20-21, 88-90, 154, 365.
 Interloping 102, 105; boosts cost 311.
 Internat'l Derrick & Equip. Co. 213, 393.
 International problems 7-14, 28, 178, 197-200.
 International Petroleum Co. 213, 217, 345.
 Internat'l position of Standard, Inc. 344.
 Interstate Commerce Commission 88, 256.
 Invasion of eastern markets 78, 153-4; 365.
 Inventions, see cracking, elec. drive, rotary.
 Inventories, crude and refined 81-2, 111, 322, 348, 366; Gulf Oil 348; other independents 348; Standard Oil Cos. 346; The Texas Co. 341, 348.
 Investing 361; vs. speculating 362-3.
 Investments, states 301-2; divisions 303; companies 304; yearly 306; Mexico 243, 244; pipe lines 88, 303.
 Iron ore, Cuba 205; exports and imports 174, 175; quantity 61, value 63; production concentrated in 3 states 167.
 Italy, buyer of lubricants 186; value, exports to, 186; per capita consumption 191; Fiat car made at Milan 118.

J

James, H. G., 105, 376 (died, 1926).
 Japan, (and Formosa) consumption, per capita and total 15, 191; production 14, 147; reserves 19, tankers 90; U. S. exports to 180-6; world commerce 195.
 Jefferson county, Tex. 162, 168 (see Spindle top).
 Jensen, Joseph, geologist 71.
 Jester, George C., geologist 300.
 Johnson, Huntley & Somers' "Business of Oil Production" 312.
 Jones, Geo. H., chairman, Standard Oil Co. of N. J., comments, Oil Board's report 271, outlook for 1927, 369.

K

Kansas 24, 28, 33, 138, 144, 146-150, 157-160, 164, 170, 302, 314, 323.
 Kansas City 30, 98; K. C. Test. Lab. 120.
 Kansas Osage Gas Co. 352.
 Katalla, Alaska, see page 25.
 Kay County Gas Co. 352 (see Marland).
 Kay-Noble Counties 160 see Tonkawa.

INDEX

Kellogg, Hon. Frank B., ex-ambassador to Gr. Brit.; special counsel, U. S. Govt.; Standard Oil Case, 1911; ex-Senator; now Sec. of State 255.
Kentucky 37, (Estil Co.) 42, 146-150, 170, 302, 323.
Kern County (more than Penns'y) 152, 258.
Kern River field, Calif. 33, 88, 155, 156, 258.
Kettering, B. F., Gen'l Motors Research 117.
Keystone Drilling Co., Beaver Falls, Pa. 43.

L

Labor conservation 41; cost 307, 313; efficiency 61, 272; intelligence 273; Latin American 202; qualities 274; troubles rare 275; turnover, refining 273.
Laboratory, Bur. of Mines 249; Mellon 296.
La Brea Rancho, Calif. 5, 28, 29.
Ladders to leadership 281.
Lago Oil & Transport Co. 346, 351; Petroleum Co. 222-3 (see Pan.-Am. P. & T.).
Lakes, Caddo, La. (see Caddo field) 149; Maracaibo Venez. 11, 215, 218, 220-3; Tamiahua, Vera Cruz, Mex. 225.
Lakeview gusher 77, 151.
Lamp, The, 81, 84, 90, 108-9, 118, 136, 151, 155, 172, 203, 206, 212, 217, 227, 235, 273-5, 296, 299, 316, 324, 359, 366.
Lands, leases, wells, value of 303.
Lane, Franklin K. 102, 297.
Lapham, H. G., The Texas Co. 339, 342, 369.
Large fields or pools—see Amarillo, Bradford, Burbank, Coalings, Cushing, Glenn, Humble, Huntington Beach, Hutchinson Co., Kern River, Long Beach, Mexia, Midway-Sunset, Monroe (gas) 149, Powell, Salt Creek, Santa Fe Springs, Seminole, Smackover 149, Sunburst (or Kevin-S.)
Largest financial rearrangement 368.
Largest individual operator 161.
La Rosa field 11, 221, 223.
Late facts 147, 278, 365-9.
Latent resources, see Latin America, Reserves, Supply and demand.
Latin America 193-244, coal resources 204; dawn of oil 204; glory of Panama 193; geologic condition 200-2; highways 203; internal trade 198; iron ore 205; La Rosa 11, 221; labor relations 202; leadership 193; natural condition 200-2; notable changes, U. S. trade 196; outlook 205; position in U. S. trade 195-7; production of emeralds and platinum 217; three countries in world trade 195; treasures and tragedies, tales of, 193; U. S. dependence 198-9, enterprise 194, sales less than purchases 195.
Latin American petroleum—characteristics 202, 221, 233; convenient location of fields 10; domestic demand limited 203; early explorations 212-3, 227; financial control, American in Colombia 217, Mexico 236-9, Peru 213; British in Trinidad and Venez. 222; geology 202, 206, 207-8, 211; production to end of 1924 205, in 1924 and 1925 223, and in 1926 147; pipe line, Colombia 217-8, 369; retarded opening of fields 204; U. S. imports 200, needing more 198-9. See also Argentina, Brazil, Cent. Am., etc.
Law, new Mexican 244.
Lawyers, leaders 282.
Leadership, lack of 102-3, 115.
Leading buyer 10, 245; consumer 191-2.
Leading discoverer, see E. L. Doheny 278.
Leading exporters, see Mexico and U. S.
Leading fields and pools 142, 143, 152, 155, 366; states, 1926, 147.
Leafax 54, 59.

Leasing outlay 310, 316.
Lefevre, Arthur, editor, The Texaco Star, 135, 338, 342, 358.
Lightning protection 328.
Lima-Indiana field 38, 141.
Lima, Ohio, prod.-rfg. center 138.
Limestone beds 23, 33, (Tamosopo) 202, 225.
Linde Air Products, see Helium 251.
Lives, often long 291.
Living costs higher without oil 301.
Little, Arthur D. and R. E. Wilson 57.
Locomotive firing, priority 95.
London Times 290.
Long Beach or Signal Hill 35, 51, 73, 155, 156, 367.
Loomis, N. E., "Refining Crude" 57.
Los Angeles 21, 29, 34-5, 53, 112, 135, 138-9, 212, 241, 278, 291, 310.
Los Angeles basin 34, 35, 69, 70-1, 88, 156, 212.
Los Angeles County 51; see also Calif., Dominguez, Inglewood, Long Beach, Montebello, Rosecrans, Santa Fe Springs, Seal Beach, Sherman or Salt Lake, Signal Hill, Torrance.
Los Angeles Times 244.
Loss in crude production, net over \$60,000,000 (1923) 74; \$218,000,000 in one field 326.
Losses, comparative in min'l industries 326; economic, see waste 100, 253.
Losses, financial 324-8; analysis of 5 sources 325; corrosion 250; evaporation 326; indirect and purely financial 324; large from cigarettes and matches 328; least from fire and explosion 327; lightning leading fire cause 327; most serious sources 326; relation, prices and conservation 325; smoking 328.
Louisiana 147, 148, 150, 157-8, 170, see Caddo, Cameron, Cassieu, Haynesville, Homer, Monroe, Shreveport.
Lubricants 56-7; U. S. in world 181.
Lubricating oil, exports, 180, 183; prices 93; regeneration 102.
Lucas, Capt. Anthony F. 41, 49.
Lufkin, E. C., ex-chairman, Texas Co. 283.
Luling, Tex. 135, 165-6, 277.
Lynch, Robt. N., San F. Ch. of Com. 153.

M

McGraw-Hill Co., 168, 318.
McIntyre, James, 116, 276.
McClesky well, 164.
McKean County, 145, 146.
Major fields, U. S. Chap. III, 31; production, 141.
Magazine of Wall Street, 246.
Magnetic points about industry, 371.
Making money in oil, 331, 359, 371; crude stocks (inventory appreciation), 324; fee ownership, 359; share ownership, 361-3; producing nat. gasoline, 360-1; trading in leases, 373; wildcatting hazardous, 359, 378.
Mammals, prehistoric, 29.
Mamonal, see Cartagena.
Manning, Van H., ex-dir., Bur. Mines, 120.
Manual for Oil & Gas Industry, 31, 71; see valuation and depletion, 317-320.
Manufacturing and mfrs., 32, 308, 332.
Maps, Argentine, 211; Ark. and La., 149; Calif., 35, 153, 258; Colombia, 215, 218; Louisiana (nor.), 149; Pacific States, 153; Pa., 145; Standard Oil marketing territory, U. S., 116; Texas, 163; Trinidad, 200; U. S. major fields, 31; Venezuela, eastern, 200; Lake Maracaibo basin, 215; W. Va., 159; World reserves, 18; consumption and production, 192; world distribution, U. S. exports, 180, 182, 185.

INDEX

- Marcus Hook, see Phila. and Refineries.
 Maracaibo Basin, 11, 201, 215, 220-223.
 Marcosson, I. F., author, "Black Golconda," 244, 252, 295, 387.
 Maritime trade, U. S., 171-187.
 Marketing, concentration of, 115; staff of an Am. company, Calif., China, 335; Jamaica, 199; So. Africa, 190.
 Market, control of, 103; retail, 332.
 Marland, E. W., founder, Marland Oil Co., 305; marvelous record of company, 352; gross and net income, 335, 367, see 281 and 303 (Who's Who).
 Marsters, V. E., 212, 279.
 Marvelous manifestations of wells, 231.
 Maryland refineries, 170; see Baltimore.
 Massachusetts, 170; see Boston; Fall River, 90.
 Mellon family, see Gulf Oil Institute, 292, 296; Mellon millions, 292; Andrew W. quoted, 173, 282; subsidiary, 108.
 Men of Titusville, 298; who find, 276; who toil, 272; quartette from Calif., 300.
 Merchant Marine, tankers, 171.
 Merchandise on hand, 341, 346, 348.
 Mergers conducive to conservation, 325; Associated-Tide Water, 330; Barnsdall-Waite Phillips, 329-30; few motives, 329; General Petroleum-Standard, N. Y., 331-2; greatest grouping, 330; Magnolia, 331; Pacific Oil, 330; Pan American, 329, 344, 351.
 Mesopotamia, 10, 19 (in Kern County).
 Mex. Eagle sold to Royal Dutch-Shell, 290.
 Mexican, 24, 70, 164-166.
 Mexican oil fields, area and location, 225; British capital, 225-244, 228; Cacalilao, 234, 235; compared with U. S. fields, 231-233; diamond drilling, 13; daily yield diminishing, 234, 236; finding major field, 229; geology, 225; "Golden Lane," 225, 229, 240; history, 227-230; Isthmian zone, 225, 228f; marvelous development, 229-231; Minatitlan, see Isthmian, Tehuantepec, 225, 228, 234f; Panuco field, 235, 229, 232, 234, 235, 239; (Cacalilao etc.), 236; physical features, 225; Tamosopo limestone, 225; two main districts, light and heavy, 225, 226, 229, 234; volcanic neck, 227; wonder wells, 229-231.
 Mexican oil industry, American entrepreneurs, 227; C. A. Canfield, E. L. Doheny, 227, 228; capital invested, 244; Ebano exploitation, 227; exports, 238-240; famous fountains, 229-231; foreign, 237; gusher in Tierra Blanca, 239-231; history, 227-230, 243; labor troubles, 202; Mexican Central Railway, 227; Mex. Eagle Oil Co., 228-230; Mexican Petroleum Co., 227; (Doheny), 229; (Cerro Azul), 230, 237, 238; (Huasteca), 239; new wells, 237; Pan American Petroleum & Transport Co. (see Huasteca and Mex. Petroleum), 351; producers (companies), 237; production, by pools, 234; declining, 234, 236; railway relations, 227, 244; revolutionary damages, 224; refining, 241; shippers, 239; Southern Pacific Ry. (East Coast Oil Co.), 229; storage capacity, 84 mil. bbls., 233; Tampico, 21, 135, 138, 139, 202, 225, 239-240.
 Mexican petroleum, age of reservoir rocks, 225, 233; asphalt, 57f, 227; gushers, 229-231, 237; gravity, 225; meaning to Americans, 24, 78, 241; to Mexico, 242; nationalization, 244; prices, 233, 24; quality, 225-226, 233; reserves, 236; threat to U. S. industry past, 236f; temperature high, 226; total output to 1927, 205; U. S. biggest buyer, 240; "Who's Who," 236; World War factor, 299.
 Mexican wells, average daily yield, 231, 232; Casiano No. 7, 229-231; Cerro Azul No. 4, 230, —, 300, —; Dos Bocas or San Diego No. 3, 228; extraordinary behavior, 231; famous fountains (3), 229; long flowing period, 231; number of producing wells, 232; Potreo del Llano, 229-230; propellant not gas pressure, 231; pumpers rare at one time, 231; salt water invasion, 18, 234.
 Mexico, 8, 10, 13-16, 26, 28, 57f; U. S. imports from, 78, 104, 236f, 240; land of silver sisal hemp and heavy oil, 224; place in Latin Am. trade of U. S., 224; vast and varied wealth, 224.
 Michigan, 149f.
 Midway-Sunset field, 77, 34, 151, 155, 156, 160, 258.
 Mineral industry (U. S.), 63; (place of petroleum by states), 149, 150, 152, 157.
 Mines, Bureau of (now in Dept. of Com.), 5, 15, 40, 41, 55, 59, 60, 62, 82, 83, 85, 99, 100, 101, 107, 114, 121, 248.
 Mining Congress Journal, 121, 322, 329.
 Mining oil sands, 42, 43, 136.
 Mining and Metallurgy, A. I. M. E., 11, 14, 120.
 Mining Journal, London, 16.
 Mining & Oil Bul., now Oil Bulletin (Los Angeles), 79, Etc.
 Moffat dome, Colo., 340.
 Monopolistic control, lack of, 102-103, 105.
 Monopolized pools, Alamo, Mex., 234, 267; Cabin Creek, 267; Casiano, Cerro Azul, Chijol, and Ebano, 227, 230, 234, 267; Saratoga, Tex., 167; Moffat, Colo. (The Texas and Transcont. companies), 340; Rainbow Bend (Kans.), 267; Reagon Co., 267; Seal Beach, Calif. (Marland), 155; Toteco-Cerro Azul (3 companies), 238; Ventura (Associated, Shell, etc.), 155; Wellington dome, Colo. (Union Oil), 349-50; Salt Creek, Wyo. (Midwest Refining in large part), 345.
 Monroe gas field, La., 149, 309.
 Montana, 28, 37, 69, 70, 78, 147, 148.
 Morris, H. C., Hoover's ex-aide, 12, 68, 177, 249.
 Most "refined" metropolis, 139.
 Motor fuels, see gasoline, chapter VII; book by E. H. Leslie, 119.
 Motorizing fishing fleet, 118.
 Movement, Pacific to Atlantic, 78-79, 365.
 Municipalities dependent on oil, 138.
 Mushroom operators, 79, 81, 102, 105.
 Mutual treasures, 288.

N

- Naptha (as synonym of gasoline), 56.
 Natal, South Africa, 119, 190.
 National Bank of Commerce, 67.
 National Better Business Inc. (formerly National Vigilante Committee), 106, 370; branches of, 384; questionnaire, 383.
 Nationalization, 244-5.
 National Museum, bulletin, 75.
 Natural gas, 22, 63-4, 101, 158-9.
 Natural gasoline, 109, 158.
 Natural resources, see chapters II and III, 19, 39, 100-102, 31f (A. C. Bedford), Division of the I. T. U., U. S. Treasury, see chap. XI; also "Manual for the Oil & Gas Industry," and valuation engineers.
 Natural treasures and tragedies, 28-29.
 Nature and origin of oil, 22-23.
 Naval reserves, 258-9; vessels, priority of, 95.
 Navarro County, Tex., see Corsicana and Powell, 164-5.
 Navy, British, 90 percent oil fired, 17; U. S., 95, 97, 251, 253, 256-9, 194.

INDEX

Neches River (Port Arthur), Tex., 170.
Negroes as finders and lessors, 294.
Net earnings, companies, 335-6; entire industry, 333.
Netherlands, 17.
New Jersey, 170; see Bayonne.
New production peaks, 140, 147.
New world power in petroleum, 344.
New York—oil port, 20, 139; refining center, 169 (N. J. side); state as producer, 147-150; Stock Exchange.
News summary for 1926, 368.
Norway, 17, 118, 180, 182.
Norwegian schooner "Maud," 17; tankers, 90.
Noteworthy world events, 368.
Number of stockholders, 294; wells in U. S., 148; in Mexico, 231, 232.

O

Occurrence of oil—geographic, 31-39; stratigraphic, 26-28; structural, 23-24.
O'Donnell, Tom., pres. A. P. I., 79.
Oil Conservation Board and its first report, 261, 315.
Oildom anticipated inquiries, 262.
Oil Bulletin, Calif., 7, 73, 87, 110, 112, 300, 323, 330-1.
Oildom, a weekly, Bayonne, N. J., 277.
Oil fields or pools of the United States (see also major fields), Amarillo or Texas Panhandle, 33, 145, 163, 363; Archer Co., 166; Batson, 70, 166-7; Beaumont (see Spindle Top), 368; Big Lake, 142, 163, 166; Bradford-Allegany Pa.-N. Y.), 72, 360; Bristol, 161; Burbank, 79, 160; Burkbnnett, 62, 166; Caddo, La., 70, 149; Carson Co., 33; Cat Creek, 37, 70; Coalina, 155; Coyote, 155; Cromwell, 161; Cushing, 33, 41, 42, 69, 78, 88, 161; Damon Mound, 70, 167; Dropright & Drumright (Cushing), 69; Edgerly, La., 70; El Dorado, Ark., 149; Eldorado, Kan., —; Electra, 142, 164; Fullerton, 155; Garber, 78; Glenn, 161; Goose Creek, 166, 167; Gulf Coast, unspecified, 167, also 33, 36, 40, 41; Healdton, 70, 161; Hewitt, 161; Hull, 70, 167; Humble, 70, 167; Huntington Beach, 34, 35, 71, 155, 156; Hutchison Co., 33, 145, 366; Inglewood, 155, 366; Jennings, 70, 167; Kern River, 70, 160; Long Beach (Signal Hill), 35, 71, 73, 142, 155, 156, 366; Luling, 142, 166; Mexia, 70, 142, 166; Midway-Sunset (Kern Co.), 34, 77, 151, 142, 156; Miranda, 166; Montbello, 155; Orange, 167; Papoose or Wetumka, 161; Powell, 72, 78, 165; Ranger-Eastland, 166; Rattlesnake, 155; Reagan Co., 267 (see Big Lake); Richfield, 155; Rosecrans, 155; Santa Fe Springs, 35, 51, 69, 100, 142, 143, 145, 151, 155, 156, 366; Seminole, 168, 366, 368; Seal Beach, 155, 352; Smackover, 80, 142, 149; Sour Lake, 70, 167; South Liberty, 167; Spindle Top, 36, 40, 76, 102, 167, 366; Sunburst, 37, 69, 78, 368; Tonkawa, 32, 70, 160, 161; Torrance, 142, 155; Ventura Ave., 151, 155; Vinton, 167; Watchorn, 161; West Columbia, 70, 167, 320; Wewoka, 161, 319, 345, 359; Wortham, 148, 165, 277.
Oil and Gas Journal, 12, 20, 34, see numerous footnotes.
"Oil Industry's Answers, The," 177, 272, 314.
"Oil Industry," by Lilley, 360.
Oil men, Pennsylvania, 298.
Oil, Paint and Drug Reporter, 28, 81, 102.
Oil Trade (Journal), 54, 92, 107, 323.
Oil Weekly, 36, 49, 98, 109, 117, 253, 287, 320, 349.
Oil, lake of 550 million barrels, 304.
Oil ports, 20, 138-9.

Oklahoma, "Heart of Mid-Continent," 157-162; Burbank and Tonkawa, 160, see oil fields geology, 24, 28, 33; Glenn discovery, 158; producer of other minerals, 157; Natural gasoline, 158; producer of other minerals, 157; prominent pools, 161; Seminole, 161, 367; summary, 161-162, 302; well costs, 312.
Oldest active operator, 368; pumper, 146; tank builder, 275; well, Calif., 151.
Operating costs, 306, 313-6.
Orcutt, W. W., v.-pres., Union Oil, 281.
Osage County or Nation, 160; financial importance, 311; Indians, 294-6.
O'Shaughnessy's "Venez. Oil Handbook," 220, 222.
Osborn, C. C., economist (ex-Marland), 315.
Outlook for Industry, W. C. Teagle, 106; Sir Deterding, 369; for 1927, 368; for Latin America, 205.
Output of leading countries, 141, 147, see production and yield.

P

Pacific Coast, 153, 172, 175.
Pasvolsky, Leo, Bur. of Economics, 7.
Panama, history, 193; seeking oil, 207; Canal, 20, 89, 90, 172.
Pan American Petroleum & Transport Co. see under "Companies"—Huasteca, 258; Mexican Petroleum, 229, 236-7, 238, 304, 335, 344, 351, 367.
Pan American republics, interdependence, 199.
Pan American Union, W. A. Reed, trade adviser, 6, 204.
Pan American Western, 304, 351, 367.
Panhandle, Texas, 33, 145, 367 (see Hutchinson County).
Paraguay, 211.
Parker, Hon. Edwin B. (chairman, U. S. Ch. of Com., 1927), 272, 338.
Participation, Standard Oil, 103.
Par value (see net profits), 336.
Pawhuska, Okla. (see Osages).
Pearson, P. H., "Surface Signs, Oil Deposits," 23, 26.
Peak production, Calif., etc., 150; five fields, 144; U. S., 140, 365-7.
Pennsylvania, 26, 28, 32, 37, 42, 43, 62, 63, 65, 145, 146-150, 298, 302, 368. (See also under "Costs," etc., chap. XIII; Bradford, McKean Co., and Philadelphia.)
Per capital consumption, 15, 191, production, 12 states, 147.
Persia, 14, 19, 147.
Peru, 14, 19, 141, 147, 193, 198, 212-214; oil exports third in value 214.
Per vehicle consumption, 110-111.
Petroleum Iron Works, 275.
Petroleum products, over 300, 57-58 (see Utilization, 94-100).
Petrol. Register, 40 Rector St., N. Y., 350.
"Petroleum: how to find it," 380.
Petroleum in So. Am. trade, 197.
Petroleum trade, 1926, Br. & U. S., 368.
Pew, J. Edgar, pres., A. P. I., 225; J. Howard, pres., Sun Oil Co., 356; J. H. Pew, Jr., 356.
Pew, Pohn G., pres., Sun Dry Dock & Shipbuilding Co., 89, 173.
Philadelphia, 20, 139, 355.
Philippines, 44, 183.
Phillips Petroleum Co., 304, 335, 354, 361.
Pipe lines and pump stations, 51-4, 87-8, 275, 303, 305.
Prairie Oil & Gas Co., Prairie Pipe Line, see under companies (Standard, N. J.).
Pittsburgh, Gulf Oil and Oil Well Supply, 135, 138.
Prevention of failure, 370, 376; frauds, 370; capital in Venez., 122, 355.

INDEX

- Pre-war prices, 114.
 Policy, U. S., internat'l., 10-14, 178.
 Pools of 14 mil. bbls. or more, 366.
 Ponca City, Marland, 282, 352.
 Potash salts, 30, 135.
 Port Arthur, Tex., 20, 135, 137, 139, 308, 341.
 Portable refineries, 170; natural gasoline plants, 361.
 Potomac river, comparison, 61, 139.
 Potrero del Llano, 229, 230.
 Premiums for better oils, 77-78.
 Prevention of failures, 375-8; frauds, 381-4.
 Price control of crude, 75; factors in upward trend, 75-76; not determined by cost, 316.
 Prices, American versus foreign, 116, 177; average, crude, 76, 317, 366; fuel oil, 93; gasoline, 114, 266-7; Beaumont or Spindle Top, 75-77; California, 77, 88, 93; comparative refined, 93; crude and gasoline, 114, 366-7; staple products, prewar and 1922, 114; danger of rise (Farish), 105; distress, 75-8, 90; export, gas and fuel oil, 181; high, crude, 76, 114; gasoline, 114; low, crude, 76, 77; gasoline, 88, 90; Mid Continent, 78, 102; Oklahoma, 93; Pennsylvania grade, 76; posted, 77; refined oils, 92-93; subnormal, 317; versus costs, 317; wildcatting relation, 359.
 Principles of investment, 362.
 Priority, income, 294; utilization, 95.
 Producers, Mexico, 237, U. S., 303.
 Producing areas, 5 large, compared, 144.
 Production: California, 142, 150, 154-156; domestic changes, 142, 366; by major fields, 141; major pools, 142, 366; by states and countries (1924-1926), 147; tremendous gain in Texas, 366; Venezuela, 221; per well, 71, 148; world statistics, 1926, preliminary, 147. See chap. V.
 Profits, how determined, 334; net of leading operators, 335; net per share, 336; ratio to par value, 337; see Net earnings.
 Protection of small investors, 381; of industry against self, 259, 369.
 Pumping Jack, 146.
- Q**
- Qualities of crude oils, 22; gravities, 39, 142; Latin American crudes, 202; Mexican, 225-226.
 Quartette of money makers—see Gulf, Humble, Standard (Ind.), The Texas Co.
 Questionnaire, Better Business Bur., 383.
 Quickening in Latin America, 204.
- R**
- Raft of reasons for failures, 374-6.
 Railway transport, 87; consumption, 96-98.
 Railway companies, comparative earnings, Baltimore & Ohio, N. Y. Central, Pennsylvania, 367.
 Ranger (Eastland County) district, 164, 166.
 Rapid finding and developing (see Smackover and Wortham), 105.
 Rapid drilling, Shell Co., Calif., 51.
 Ratios, carbon to hydrogen in coal, 24; assets to capital stock; reserves to rate of removal, 19, 47.
 Reagan County, see Big Lake.
 Reasons for failures, 374-6.
 Recovery of oil from deposits, 42, 43, 72; products from crude, 60, 85, 86, 367.
 Redfield, A. H., 6, 206, 208.
 Reduction of risks, 378.
 Reed, Ralph J., see Lightning protection.
 Refineries, 55, 83, 87, 137, 161, 170; Barnaca-Bermeja, 216; British, 188, 189; California, 169; Los Angeles district, 139, 170; New York or Bayonne dist., 139, 170; Port Arthur, 139, 170, 341-2; principles in locating, 168; portable, Tampico, 242; world's largest, 137, 368.
 Refiners, why so many fail, 376.
 Refining, cracking, 57, 60; growth of industry, 83; more stabilizing than producing, 333; skimming or topping, 170; straight run, 54-57.
 Regulations, 245.
 Reid, W. A., trade adviser, Pan Am Union, 6.
 Reinhold, O. H., 31, 44, 51, 71, 312, 400.
 Rejuvenation, 41, 71.
 Relief train of gasoline, 112.
 Renting drilling tools, 312.
 Requa, Mark L., oil director, U. S. Fuel Administration, 76, 277, 300.
 Reserves, 19, 39, 255, 259, 262-3, 264-5.
 Restrictions, Americans abroad, 12-13; war-time consumption, 299.
 Return of capital, 321.
 Retrospect of years before 1926, 365.
 Review of recent years: (1923), 104-6; (1924-5), 304; (1925-6 and outlook for 1927), 366-9.
 Review of Reviews, abstract of author's article in *The Eng. Mag.*, 43.
 Richardson, G. B., 6, 365.
 Richest tribe in the world, 252, 294-6; (financial importance of holdings), 311 (see Osage County).
 Richest well, Abrams No. 1, 320.
 Rig and Reel, 43, 210, 212, 274, 286, 308, 328, 345.
 Risks, reduction of, 378.
 Rittman, W. F., chemical engr., 280, 282.
 Ritz-Carlton Hotel, oil heating, 99.
 Roads financed by oil, 301.
 Rockefeller, John D., 5, 61, 87, 291.
 Rocky Mtn. field, 31, 36, 41, 141; market, 116; "wreckage," 372.
 Rocky Mtn. Petrol. Assn., 41.
 Ross, Victor, director, Imperial Oil, Ltd., author of "Evolution of the Oil Industry," 301, 305.
 Rotary drilling, 50-1; electric drive, 308.
 Roxana Petroleum Corp., see Shell Union.
 Royal Bank of Canada, 219, 360.
 Royal Dutch-Shell, 12, 16, 103, 290, 350, 368.
 Rules of Hammond to avoid losses, 382.
 Russia, 7-9, 11, 14, 15, 18, 19, 26, 140-1, 147, 152, 177, 191-2, 195.
- S**
- Salaries and wages, 307, 313.
 Salt Creek field, 28, 70, 142-3, 145, 266, 345.
 Salt domes, 36, 40, 162; see Gulf Coast and Isthmian (Mex.) fields.
 Salt Lake or Sherman field, 29, 35.
 Salt water, 23, 41, 78, 228, 231.
 Salvage of well equipment, 314.
 San Diego (Naval sta.), 21, 123, 127.
 San Francisco, 303.
 San Pedro, 29, 90, 138 (see Los Angeles).
 Sands, R. M., secy., Pan-Am. Western, 352.
 Santa Fe Springs, 35, 51, 69, 71, 142-3, 145, 376.
 Saturday Evening Post, 99, 295, 316, 373.
 Scandinavia, 187; see Norway, Den., Sw.
 Scherer, Jas. A. B., D.D., Calif. Inst. of Tech., 291.
 Schwab, E. A., Natl. Vigilance Com., 373.
 Scotland, 14, 16, 17, 188; see Shale oil.
 Securities, buying, 361-4; listed, 361-5; par value, common stock, 336.
 Security, 3 qualities, 362.
 Seismograph and torsional balance, 163.
 Seminole, leading field, 161, 366, 369.
 Seneca Oil Co., see E. L. Drake, 63.
 Senate, U. S., 103; Senator Cameron, 347.
 Service of great fortunes, 290.
 Shale(s), 22, 23, 24, 42; — oil, 14, 17; — work, U. S. Geol. Survey, 255.

INDEX

- Shell Co. of Calif., 12, 48, 51, 73; see Shell-Union, 350; and Royal Dutch-Shell. Shipments from Mexico, 238-9.
- Shipping, 17, 20, 171; tankers, 90, 171.
- Shipping Board, U. S., 12, 89, 256.
- Shoup, Paul, Pacific Oil Co., 300.
- Shreveport, La., 135, 138.
- Siberia and Sakhalin, 19.
- Signal Hill, see Long Beach.
- Sinclair Consol. Oil Corp., 144, 294, 304.
- Skelly Oil Co. (Who's who), 303-4, 336.
- Skimming and topping, 170, 241.
- Slosson, E. G., Science Service, 117.
- Smith, Geo. O., U. S. G. S., 61, 93, 101, 252, 261, 277, "Program of Profit," 334.
- Smith, Phillip S., in Alaska, 254.
- Smith, Roland H., pres. Oklahoma Co., 278; address before Oil Board, 359.
- Snow, C. D., U. S. Chamber of Com., 195.
- Snyder, Meredith P., banker and ex-mayor of Los Angeles (friend of author), 112.
- Soup-bone problem, refining, 84-5, 116.
- Sources, capital, 357; crude oil, 322; future supply, 119-21; imports, 200; income, 332, 359.
- Specifications, gasoline, 59.
- Speculating vs. investing, 362-3.
- Sperling's Journal, quoting E. M. Edgard, 18.
- Spindle Top, Jeff. Co., 40, 41, 145, 167, 366.
- Stabilizing, function of storage, 81, 322; influence of foreign trade, 66, 177; of associations, 92.
- Standardization, 66; A. P. I. com., 308.
- Standard Oil Companies: Assets, 346; control, 103; dividends since dissolution, 338; div. rate on common, 338; domestic market(s), 103, 116; earnings, 335; mergers, 329-31, 344; monopoly, 103; net profits, 335, 367; share, foreign trade, 103; securities, 346; tanker fleet, 173.
- Standard Oil Co., 51, 115; Calif., 294, 303, 330-1, 331, 333;—Ind., 343-6, 367;—N. J., 10, 11, 57, 64; (tankers), 173, 178, 213, 217, 222-3, 235, 237, 239, 243, 294, 296, 299, 304, 323, 335-8, 358, 367; 369 (see also Geo. H. Jones, *The Lamp*, W. C. Teagle; Carter, Humble, Internat'l. Prairie and Transcontinental companies); —N. Y., 178, 304, 329, 331-2, 336-8, 367.
- Standards, Bur. of, see Dept. of Com.
- Starke, Eric A., 77.
- State Department, 12, 244, 255.
- Stewart, Lyman, pioneer, author's first employer in the industry, 2, 291, 349.
- Stewart, Col. Robt. W., 282, 344, 346.
- Stockholders, number in 5 oil co.'s, 294.
- Stocking's, "The Oil Industry, etc.," 315.
- Stocks, crude, 81, 82, 104, 322, 366; fuel oil, 82, 367; gasoline, 82, 104, 111, 367; kerosene, 82, 367; refined and semi-refined, 82, 322, 367; Standard Oil, 103.
- Stratigraphic distribution, 26, 28, 201, 211.
- Stone, Warren S., banker, 288.
- Struth, H. J., see *Oil Trade*, 305, 308.
- Success essential to industry, 301.
- Sudden need of new capital, 356.
- Suitability of securities, 362.
- Sun Oil Co., 149, 304, 335-7, 353, 355, 362.
- Sun Shipbuilding & Dry Dock Co., 174, 355.
- Supply and demand, 72, 78, 81, 111, 321, 366-7; report, A. P. I. Committee of Eleven, 168.
- Supreme Court, 245.
- "Surface Signs of Oil Deposits," by P. H. Pearson, Ph. D., Upsala, Colo., E. Orange, N. J., 25, 26.
- Sullivan Machinery Co., core drills, 46, 49.
- Sweden, 180, 182, 185, 186, 187.
- Swensondale Oil Co., 123.
- Swindell, Geo. M., ex-sec'y., Ch. of Mines & Oil.
- Swindling promotions, 372-9.
- Synoptical story of 3 states, 167.
- ## T
- Tampico, Mex., 21, 90, 135, 139, 239.
- Tanker, first built in England, 88.
- Tanker fleet, function in war, 173; Shipping Board, 89, 256; U. S., 90, 171; world, 90.
- Tankers, company ownership, 345; preponderance, 171.
- Taxable net income, 333, 340.
- Tax burden lightened, 322.
- Tax, income, Mex., 243-4; U. S., 19, 247-8, 307.
- Taxpayers, important, 346.
- Teagle, Walter C., pres., Standard, N. J., 106, 130, 261, 269, 323, 367.
- Technologists, 40, 60, and Chap. XII; see also Bureau of Mines.
- Ten-year tale of tragedy, 372-3.
- Tertiary beds, chief source, Africa, Asia, 26; Calif., 33; Europe, 26; Gulf Coast, 28, 36; Mexico, 28, 225; Venezuela, 220.
- Texaco Star*, The, 101, 110, 135, 146, 161, 183, 187, 190, 197, 199, 205, 207, 232, 238, 239, 246, 275, 289, 302, 308, 320, 321, 335, 340, 341, 343, 363.
- Texas Company, The, 41; (Japhet lease), 70, 92, 107, 110, 304, "A Type Study in Oil," 338-343, 358; the chairman, 361; comparisons with Gulf, Humble and Standard of Indiana, 343-348; dividends, leading independent in payment of, 337, 341, 344; earnings, 335, 340, 367; further financial information, 340-341; history, 339; in Mexico, 237-239; officials, 343; physical facts (production, etc.), 339; reasons for selection, 338; reorganization, 343, 368; some leading stockholders, 342; surveying pipe line, 275. See also Beaty, Cosgrove, Dennison, Holmes, Lapham, Lefevre, and *The Texaco Star*.
- Texas, 23, 24, 28, 30, 32, 33, 36, 40, 41, 62; (Corsicana-Powell), 69, 76, 78; (refineries shut down), 84, 138, 142, 145, 150, 162, 168, 170; rancher, 123, 359; tragedies, 372.
- Time to attain peak, Wortham, 165.
- Titusville, 1, 62, 63, 145; Iron Works, 204.
- Tonkawa, see Oil fields.
- Topila, Mexican field, 234.
- Topping or skimming plant, 170.
- Toteco-Cerro Azul, 234, 238.
- Total output, 5 fields to 1925, 160.
- Trade, domestic, 153; foreign, 195; maritime, 171-200; Latin American, 195-200.
- Tragedies, 5, 7, 10, 28, 29, 72; (over-production), 79, 81, 105, 369; (over-building) 135; (financial), 104-105, 305; ten-year tale, 372; tracing causes, 374; transportation, 87-88, 112, 305.
- Transcontinental Petroleum Co., 235.
- Transportation, 10, 51-4; (costs), 87-90, 112, 171-3; The Texas Co.'s pipe lines and tankers, 339.
- Treasures, economic, 86, 94, 99, 100; financial, see Assets, Dividends and Income; geographic, 135; governmental, 247; human, 293; in dividends, 337; Mexican, 242-3; mutual, 288.
- Trinidad, 14, 19, 96, 199, 200-1, 203, 206.
- Tulsa, 135-7; (West Tulsa) 139, 161, 170.
- Turkish petroleum, 8-11.
- Type study of a successful company, 338.
- ## U
- Union Oil Co. of Calif. and its Bulletin, 1, 17, 39, 52, 53, 58, 80, 89, 92, 96, 112, 120, 304, 335-7, 349, 362, 364-5, 367, 376.
- Unique location of Los Angeles, 138.
- Unit cost of cable drilling, 313; core drilling, 311; rotary (\$8-\$25), 314.

INDEX

Unit development of a pool, 266-7.
 Unlike coal mining and manufacturing, 305.
 United Kingdom, 15; petroleum trade, 187-190, 368; foreign commerce, 195-6.
 United States, 5, 8, 10, 12, 15, 19, 90; production, 65, 140-1, 147, 365-9.
 U. S. Commerce Reports see Dept. of Com.
 U. S. Chamber of Commerce, see Chamber.
 Unscrupulous promoter, 373.
 Uren, Lester C., prof. of petrol., University of California, 325.

V

Vacuum Oil Co., 304, 335-338 (60th anniversary), 368; Pres. Edward Prizer, 357.
 Value of commerce, 20; leading nations, 195; 15 best customers, 196; relation of oil to total imports of Latin Am. from U. S., 198; U. K. imports of petroleum, 187.
 Value of mineral output, 63, 148-9.
 Value of petroleum, agricultural, 20; crude, 65, 319-20; comparative, 97; economic, 57, 61; exports, 179, 368; export trade, 177; governmental, 245, 247; natural gasoline, 150, 158, 360-1; imports from Mexico, 242; world trade of leading nations, 195.
 Valuation of oil land, 318-20; assessed, 320; barrel-day method, 319; various methods, 319.
 Values of oil properties, 319-20; definition, 318; royalty interest, 320; specific, 319-20.
 Van der Gracht, geologist, 44, 281.
 Van Dyke, dean of oil men, 298, 355.
 Van Nostrand, D., Co., Inc., 360.
 Veatch, A. C., geologist, 254.
 Venango County, Pa., 145, 146.
 Venezuela, 10, 11, 14, 19, 140, 147, 191, 220-3, 369; American operators, 222.
 Ventura (Ave.), Calif., 151, 155; Consolidated Oil fields.
 Vernon (Calif.) refinery, 139, 170.
 Vinton pool, 70, 163, 164, 167.
 Volcanic arch, W. Va., 65; necks or plugs, Mexico, 202, 225, 227; origin, 22.

W

Wage earners, number producing, 272; refining, 83; treatment by employers, 243, 285.
 Wages and salaries not excessive, 307.
 Wage scale for oil-field workers, 313.
 Waid, Wm. Ash, Osage oil inspector, 295.
 Waley-Cohen, Sir Robt., director, Shell Union, "Economics of the Oil Ind.," 316.
 Wall Street Journal, 8, 16, 77, 90, 106, 156, 161, 164, 222, 224, 241, 281, 288, 294; see also chap. XIII.
 War factor, 59, 247, 298; prices, 299; activities, Petrol. Committee, 298.
 Warnings to investors, 30, 59, 316, 369; see also Chapter XIV.
 Washington, or D. C., 6, 127, 247, 257.
 Wastes, causes, 100-1, 124, 324; economic, 66, 72, 74, 100, 121; financial, 43, 301, 324. See Financial losses and conservation.
 Water drive or flooding, 72, 366; emulsion, 52; exclusion, 40-42; function, in origin and natural storage, 23; intrusion into oil sands, see Salt water; in rotary drilling (with mud), 51; separation, 52; transportation, 88-90, 171; works system compared, 53.

Waverly Handbook, 54, 120.
 Welch, R. L., A. P. L., 103; Welliver, J. C., 271.
 Wells, average depth, 72, 105, 232; deep, 30, 48, 51, 73, 155-6, 167, 309, 369; number, 72, 148; profitable, 229-30, 320; see Yield per value.
 West Indies wanting in oil, 207.
 Westinghouse Electric & Mfg. Co., 309; see Cope and Dralle.
 West Virginia, 28, 30, 37, 157-9, 302.
 Wheeler Ridge, Calif., 64, 360.
 White, David, ex-chief geol., U. S. Geol. Survey, 7, 12, 19, 26, 253, 281.
 White, Edward, statistician, I. T. U., 248.
 White, Israel C., 30, 64, 65, 229.
 Who's who in oildom, 303.
 Why independent refiners fail, 376.
 Why rogues prey on petroleum, 371.
 Wichita County, Tex., 164.
 Wichita, Kan., 138; Wichita Falls, Tex., 138.
 Wickett, F. H., chairman; Pan Am. P. & T., 282.
 Wilbarger County, Tex., 164.
 Wildcatters, 277-8, 378; see Benedum, Do-heny, Esperson, Humphreys, Slick, Smith.
 Wildcatting, basis for industry, 277-8; how to win at, 378-80; wastes in, 43, 311, 380.
 Wiltbank, H. C., ex-ed., *Our Merchant Marine*, 171.
 Winchester, Dean E., U. S. G. S., 255.
 Work, Dr. Hubert, Secy. of Interior, 14, 130, 252; Chairman of Oil Board, 130, 248, 261, 264.
 Working capital, definition of, see The Texas Co. (current assets minus current liabilities), 343.
 World, Assoc. Advertising Clubs of, 106; — National Vigilance Committee now Natl. Better Business Bureau Incorp., 383.
 World commerce, 195; consumption, 191-192; United States, 176, 179; geology, 26; production from Tertiary, 26; production by countries, 14, 147; relations, see International, 7-18; reserves, Jan. 1, 1924, 19; share of U. S., 14, 26, 140-1; and Mex., 233.
 Worth of crude oil at the well, 317.
 Worth, distinction between gross and net, 377.
 Wortham, Freestone Co., Tex., 165.
 Wrather, W. E., geologist, 276.
 Wright, Chas C., poet, 64.

Y

Yield per acre, 70 (see Spindle Top, 1926-7); bond, percent, 362; crude oil per day (U. S.), 71-72, 104, 148, 367; (Mex.), 236; per capita by states, 147; per square mile of state areas, 147; per well, 71. See also output, production, recovery.
 Yield of alcohol, 119; benzol, 120; shale oil, 121.
 Young, Arthur N., State Dept., 255.
 Young County, Tex., 32.

Z

Zacomiztle, Mex., 231, 234f, 286.
 Ziegler's "Popular Oil Geology," 24, 68.

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